Field Manual
No. 5-277

***FM 5-277**
HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 9 May 1986

B A I L E Y B R I D G E

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*This publication supersedes
TM 5-277, 3 August 1972.

FM 5-277
C1

Change 1

Headquarters
Department of the Army
Washington, DC, 15 August 1991

M2 BAILEY BRIDGE

1. Change FM 5-277, 9 May 1986, as follows:

Remove old page	Insert new page
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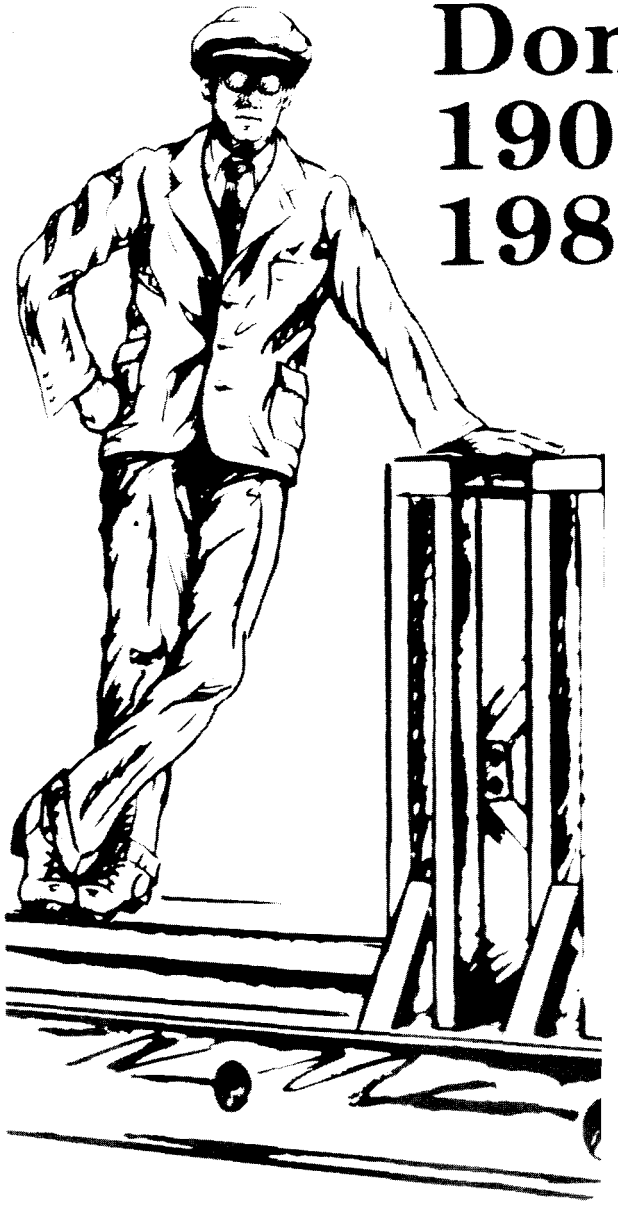
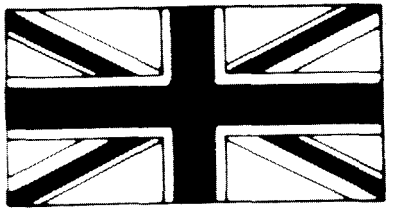


Donald Bailey
1901
1985



PREFACE

This manual is intended for use by engineer commanders, staff officers, combat engineers, and bridge specialists who are required to build the Bailey bridge.

The purpose of this manual is to provide the user instructions needed to build the standard Bailey bridge and its several variants. It describes bridge components, loading and transport, methods of assembly, and maintenance. It also describes special applications, such as two-lane, extra-wide, deck, railway, pier- and barge-supported bridges, and towers built from Bailey bridge components.

The Bailey bridge has several distinctive features. It is built by manpower alone. It is made entirely from prefabricated parts, the most notable of which are its light-steel panels linked by pinned joints. It is a 'through-type bridge. And it can be moved from one site to another.

The Bailey bridge was invented by *Donald Coleman Bailey,* an English civil engineer. In 1941, Bailey gave his first sketch of the bridge to the British War Office which paid him the equivalent of $48,000 in 1985 American currency.

The Bailey bridge used in World War II was designed to be moved, rebuilt, or replaced in several hours, even under enemy fire. It was used widely and well by Allied armies in Italy and northwest Europe, 1943-45. British Field Marshal Lord Bernard Law Montgomery said: "Without the Bailey bridge, we should not have won the war. It was the best thing in that line we ever had." Donald Bailey was knighted in 1946 for this contribution to the Allied victory in World War II.

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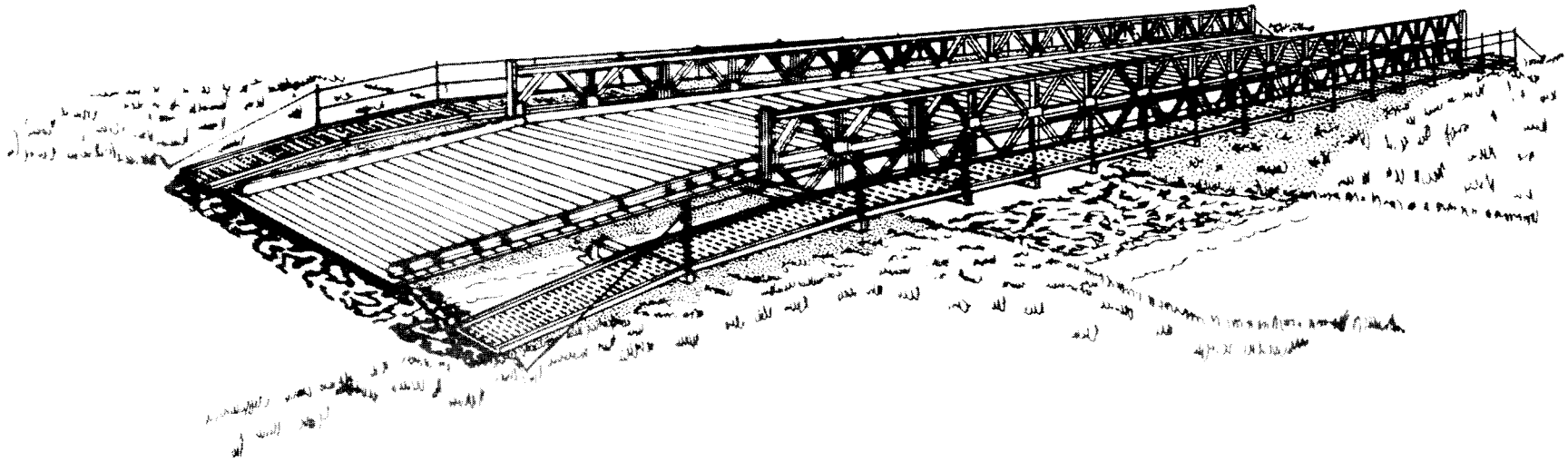
Part One
THE BAILEY M2 BRIDGE



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CHAPTER 1

HISTORY AND USE OF THE BRIDGE

At the outset of World War II, the United States (US) Army sought a versatile bridge that could span a variety of gaps and be quickly assembled by manpower alone. For this reason, we adopted the design for the British prefabricated Bailey bridge, US nomenclature Ml. We revised the design to provide a greater roadway width of 12% feet and designated it the Panel Bridge, Bailey M2 (Figure l-l). The British then modified the US version by widening the bridge again, thus producing the extra-wide Bailey M3 bridge. The US Army does not stock the M3 bridge in its arsenal. The Bailey bridge is a through-type truss bridge, the roadway being carried between two main girders. The trusses in each girder are formed by 10-foot panels pinned end to end. In this respect, the Bailey bridge is often referred to as the "panel" or "truss" bridge.

ADVANTAGES

Some of the characteristics that make the Bailey bridge valuable to field commanders are—

- It is easy to install. Each part of the Bailey bridge is a standard machine-made piece and is interchangeable among spans. Inmost cases, no heavy equipment is required to assemble or launch a Bailey bridge; only basic pioneer skills and equipment are needed.
- It is highly mobile. All parts of the bridge can be transported to and from the bridge site by 5-ton dump trucks and trailers.
- It is versatile. Standard parts can be used to assemble seven standard truss designs for efficient single spans up to 210 feet long and to build panel crib piers supporting longer bridges. With minor nonstandard modifications, the expedient uses of bridge parts are limited only by the user's imagination.

CONSTRUCTION

Transverse floor beams, called transoms, are clamped to the bottom chords of the trusses and support stringers and decking. Sway braces between the girders provide horizontal bracing; rakers between the trusses and transoms keep the trusses upright; and bracing frames and tie plates between the trusses provide lateral bracing within each girder.

Main girders

The main girders on each side of the centerline of the bridge can be assembled from a single truss or from two or three trusses side by side. For greater strength, a second story of panels can be added to the trusses. The upper stories are bolted to the top chord of the lower story. For greatest strength, a third story is added. These three basic types are shown in Figure 1-2 (page 4). The types of possible truss assemblies are given in Table 1-1 (page 4). A single-truss, double-or triple-story bridge is never assembled because it would be unstable. All triple-story bridges with the deck in the bottom story are braced at the top by transoms and sway braces which are fastened to overhead-bracing supports bolted to the top chords.

Materials

The decking, called chess, is wood. Panels, end posts, transoms, and ramps are a low-alloy, high-tensile steel. All other parts are carbon structural steel. All joints in the parts are welded.

Deck

The clear roadway between curbs, called ribbands, is 12 feet 6 inches wide. The transoms supporting the roadway are normally set on the bottom chords of the bottom story. Footwalks can be carried on the transoms outside of the main trusses on each side of the bridge.

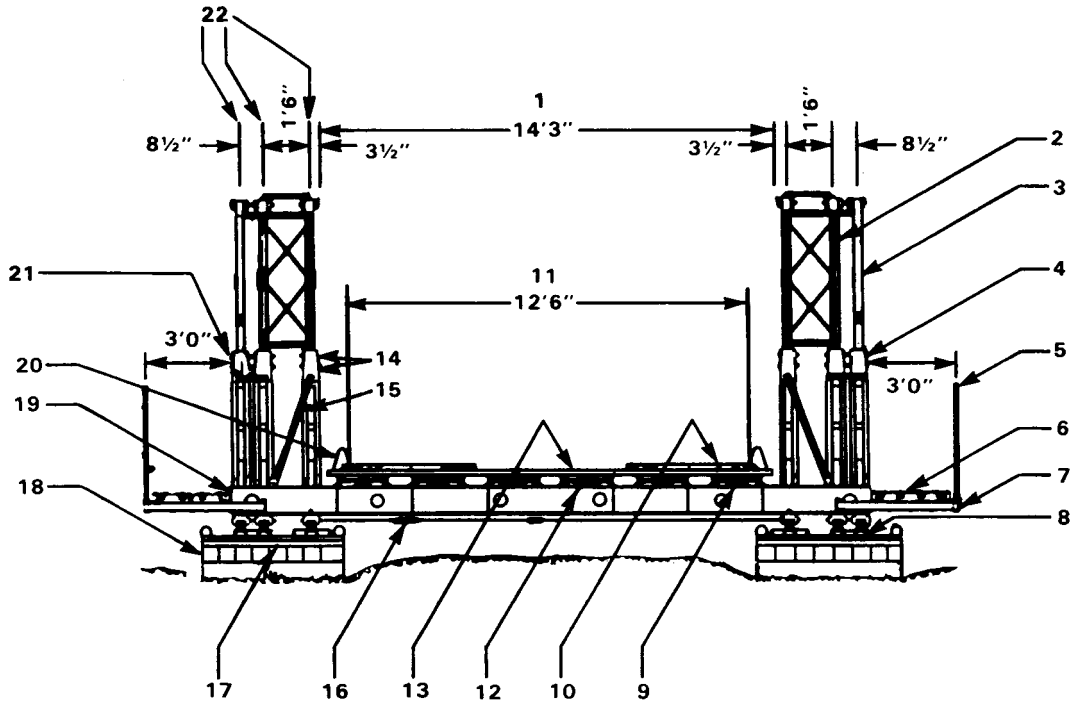
Bearings

End posts pinned to the end of each truss sit on cylindrical bearings which rest on a steel base plate. On soft soil, timber grillage is used under the base" plates to distribute the load. The bridge can be assembled between banks of different elevations, but the slope should not exceed 30 to 1.

TYPES OF STRUCTURES

Panel bridge equipment can be used to assemble fixed bridges and panel crib piers and towers. Other special structures such as floating bridges, suspension bridges, retractable bridges, and mobile bridges, can be assembled using special parts. Panel bridge equipment is normally used to assemble fixed simple-span, through-type bridges from 30 to 210 feet long. The bridge can be assembled to meet varying conditions of span and load. Bridge weight per bay is given in Table 1-2 (page 5). The following special assemblies are also possible:

- Two-lane, through-type bridges; deck-type bridges; railway bridges; bridges on piers; and floating bridges can be built with panel bridge equipment.
- Panel crib piers and towers up to 70 feet high supporting continuous spans, and up to 110 feet high supporting broken spans, can be assembled with panel bridge equipment and special crib-pier parts.
- Many expedient structures can also be built with panel bridge equipment. These include causeways, box anchors, towers for floating bridge cables, and loading hoppers and gantries.



1 CLEARANCE BETWEEN TRUSSES	12 PLAIN STRINGER
2 BRACING FRAMES	13 CHESS
3 PANEL	14 PANEL PINS
4 END POST	15 RAKER
5 FOOTWALK POST	16 SWAY BRACE
6 FOOTWALK	17 BASE PLATE
7 FOOTWALK BEARER	18 GRILLAGE
8 BEARING	19 TRANSOM
9 BUTTON STRINGER	20 STEEL RIBBAND
10 WEAR TREAD	21 SHORT PANEL PINS
11 ROADWAY	22 CENTERLINE OF PANELS

Figure 1-1 ***Panel bridge, Bailey type M2***

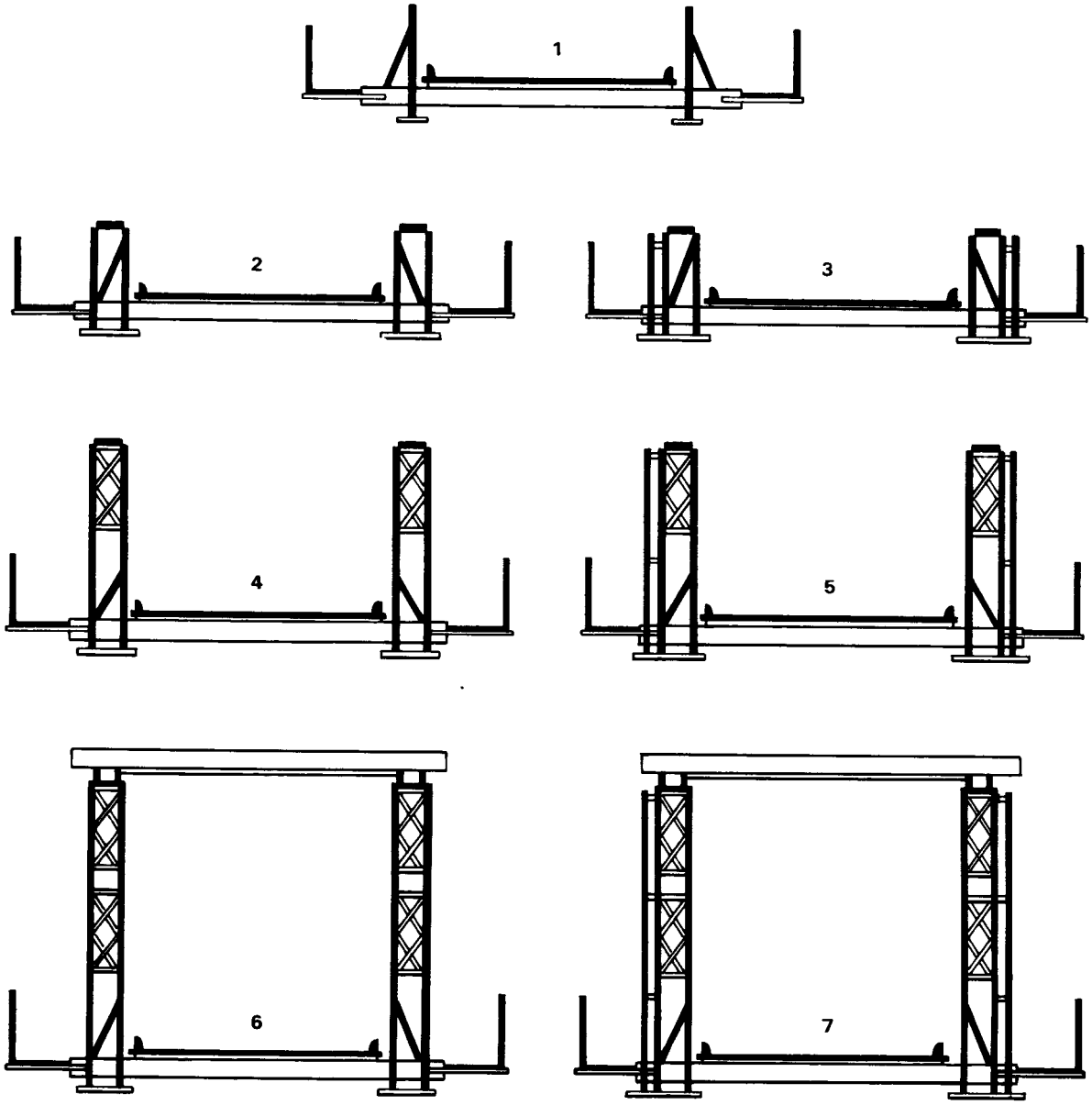


Figure 1-2 ***Single-, double-, and triple-truss assemblies***

1 SINGLE-TRUSS SINGLE-STORY (SS)
2 DOUBLE-TRUSS SINGLE-STORY (DS)
3 TRIPLE-TRUSS SINGLE-STORY (TS)
4 DOUBLE-TRUSS DOUBLE-STORY (DD)
5 TRIPLE-TRUSS DOUBLE-STORY (TD)
6 DOUBLE-TRUSS TRIPLE-STORY (DT)
7 TRIPLE-TRUSS TRIPLE-STORY (TT)

Table 1-1 ***Abbreviations for single-lane panel bridges, Bailey type M2***

TYPE		USUAL	
TRUSS	STORY	NOMENCLATURE	ABBREVIATION
Single	Single	Single-single	SS
Double	Single	Double-single	DS
Triple	Single	Triple-single	TS
Double	Double	Double-double	DD
Triple	Double	Triple-double	TD
Double	Triple	Double-triple	DT
Triple	Triple	Triple-triple	TT

This change supersedes page 5.

Table 1-2 ***Weight of M2 panel bridge in tons per bay***

TYPE OF CONSTRUCTION		WEIGHT IN TONS PER BAY						
		SS	DS	TS	DD	TD	DT	TT
Bridge bays		2.76	3.41	4.01	4.66	5.88	6.46	8.29
Launching-nose bays		1.00	1.64		2.90			
Decking	Chess and steel ribbands	0.66	0.66	0.66	0.66	0.66	0.66	0.66
	Stringer only	0.79	0.79	0.79	0.79	0.79	0.79	0.79
	Wear treads (four 3" x 12" panels on each side)	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Miscellaneous	Footwalks	0.17	0.17	0.17	0.17	0.17	0.17	0.17
	Overhead-bracing (supports, transoms, sway bracing and chord bolts)	0.54	0.54	0.54	0.54	0.54	0.54	0.54

[1] Footwalks and wear treads not included.
[2] Overhead bracing included.

CHAPTER 2
BASIC EQUIPMENT

BRIDGE PARTS 6
ERECTION EQUIPMENT 15
BRIDGING TRUCK LOADS 19

The Bailey M2 bridge set contains 29 different items of bridge parts and 30 items of erection equipment. Table A-1 in Appendix A shows the number of parts needed to build a specific Bailey bridge.

WARNING: Due to the size and weight of components, personnel are advised to use extreme care when handling them. Failure to do so may result in serious.

BRIDGE PARTS

PANEL

The panel (Figure 2-1) is the basic member of the bridge. It is a welded, high-tensile steel truss section 10 feet (3.0 meters) long, 5 feet 1 inch (1.5 meters) high, and 6 1/2 inches (16.5 centimeters) wide. It weighs 577 pounds (262 kilograms) and can be carried by six soldiers using carrying bars.

The horizontal members of the panel are called chords. Both chords have male lugs at one end and female lugs at the other. Panels are joined end to end by engaging these lugs and placing panel pins through the holes in the lugs. On the top of the bottom chord are four seatings or dowels. The beams that support the bridge roadway will be clamped to these dowels. Table 2-1 lists the holes in the panel.

PANEL PIN

The panel pin (Figure 2-2) is 8 5/16 inches (21.1 centimeters) long, 1 7/8 inches (4.8 centimeters) in diameter, and weighs 6 pounds (2.7 kilograms). It has a tapered end with a small hole

Table 2-1 ***Holes in panel chords and verticals***

POSITION	TYPE OF BOLT REQUIRED	USE
Near each end of bottom chord	Sway brace pin	Fasten end of sway braces
Top and bottom chords	Bracing bolt	Fasten bracing frames between two inner trusses
Top and bottom chords	Chord bolt	Fasten chords of multistory bridges
End verticals	Bracing bolt	Fasten rakers
		Fasten bracing frames between two inner trusses
		Fasten tie plates between second and third trusses
Bottom of all verticals	Transom clamp	Fasten transom by insertion of transom clamp

for a retainer clip. A groove is cut across the head of the panel pin parallel to the bridge pin retainer hole. Panel pins should be inserted with the groove horizontal; otherwise, the flanges of the panel chord channels make it difficult to insert the retainer clip.

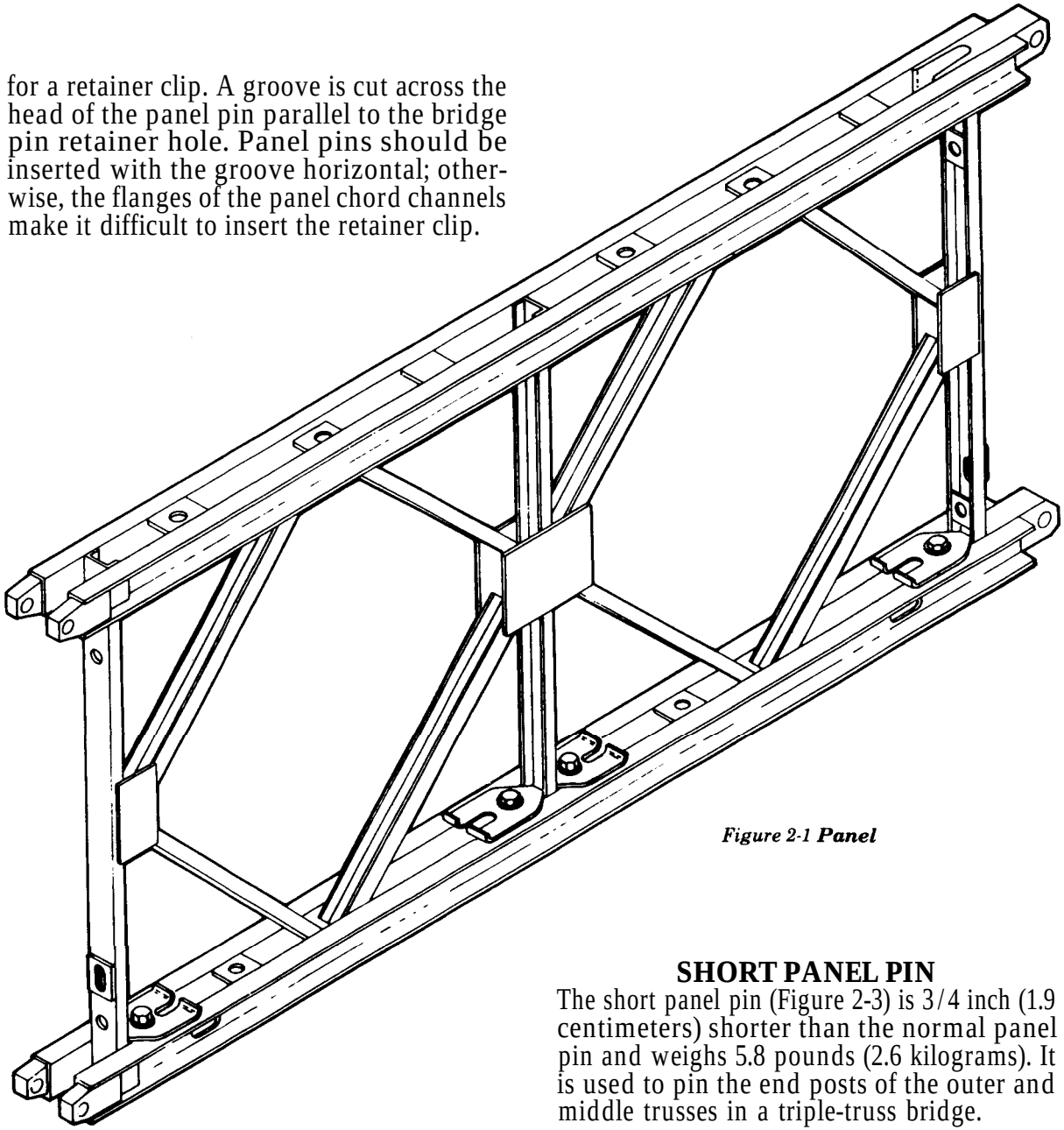


Figure 2-1 ***Panel***

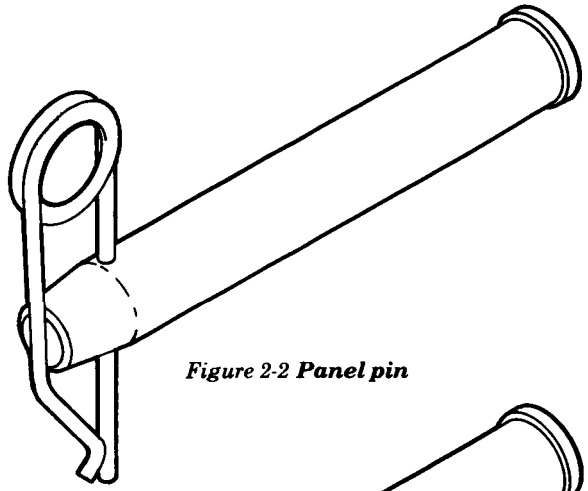


Figure 2-2 ***Panel pin***

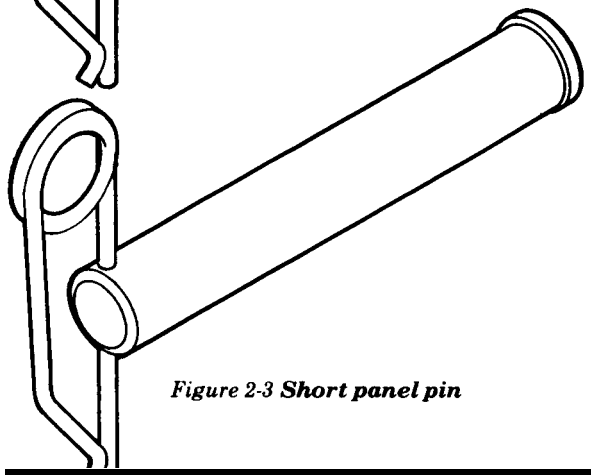


Figure 2-3 ***Short panel pin***

SHORT PANEL PIN

The short panel pin (Figure 2-3) is 3/4 inch (1.9 centimeters) shorter than the normal panel pin and weighs 5.8 pounds (2.6 kilograms). It is used to pin the end posts of the outer and middle trusses in a triple-truss bridge.

WARNING: Never jack against transoms that are held in place by transom clamps, as the clamps will fail. This failure may result in severe injury or death and/or extreme damage to bridge components.

TRANSOM

The transom (Figure 2-4, page 8) is a steel beam that supports the floor system of the bridge. It is 10 inches (25.4 centimeters) by 19 feet 11 inches (6.1 meters) long. It has a 4 1/2-inch (11.4 centimeters) flange and a 5/16-inch

(0.8 centimeter) cover plate on each flange. The transom weighs 618 pounds (280 kilograms). It can be carried by eight soldiers using carrying tongs clamped to the upper flange or carrying bars inserted through holes in the web.

The underside of the transom has six holes into which the panel dowels fit. The transom rests on the lower chord of the panel and is held in place with a transom clamp. The upper side of the transom has six lugs with an additional lug near each end. The stringers and rakers (explained later in this chapter) attach to these lugs.

Transoms are normally spaced 5 feet (1.5 meters) apart, one at the middle and one at the end of each panel, to support vehicles of class 70 or less. Four transoms per bay—two in the middle and one at each end of the panel—are required to support vehicles over class 70.

WARNING: Transom clamp is a hinged component; use care when handling to prevent injury.

TRANSOM CLAMP

The transom clamp (Figure 2-5) is a hinged screw-in type clamp, 13 1/2 inches (34.3 centimeters) high and 8 inches (20.3 centimeters) across the top. It weighs 7 pounds (3.2 kilograms). It clamps the transom to the vertical and bottom chord of the panel. It is tightened by a vise-handled screw.

WARNING: Sway brace is a multi-hinged component; use care when handling to prevent injury.

SWAY BRACE

The sway brace (Figure 2-6) is a 1 1/8-inch (2.9 centimeters) steel rod, hinged at the center, and adjusted by a turnbuckle. It weighs 68 pounds (30.8 kilograms). At each end is an eye, and a chain with a pin attached. This pin is inserted through the eye to the sway brace to the panel. The sway brace is given the proper tension by inserting the tail of an erection wrench in the turnbuckle and screwing it tight. The locknut is then screwed up against the turnbuckle. Two sway braces are required in the lower chord of each bay of the bridge, except the first bay of the launching nose, and in each bay of overhead bracing.

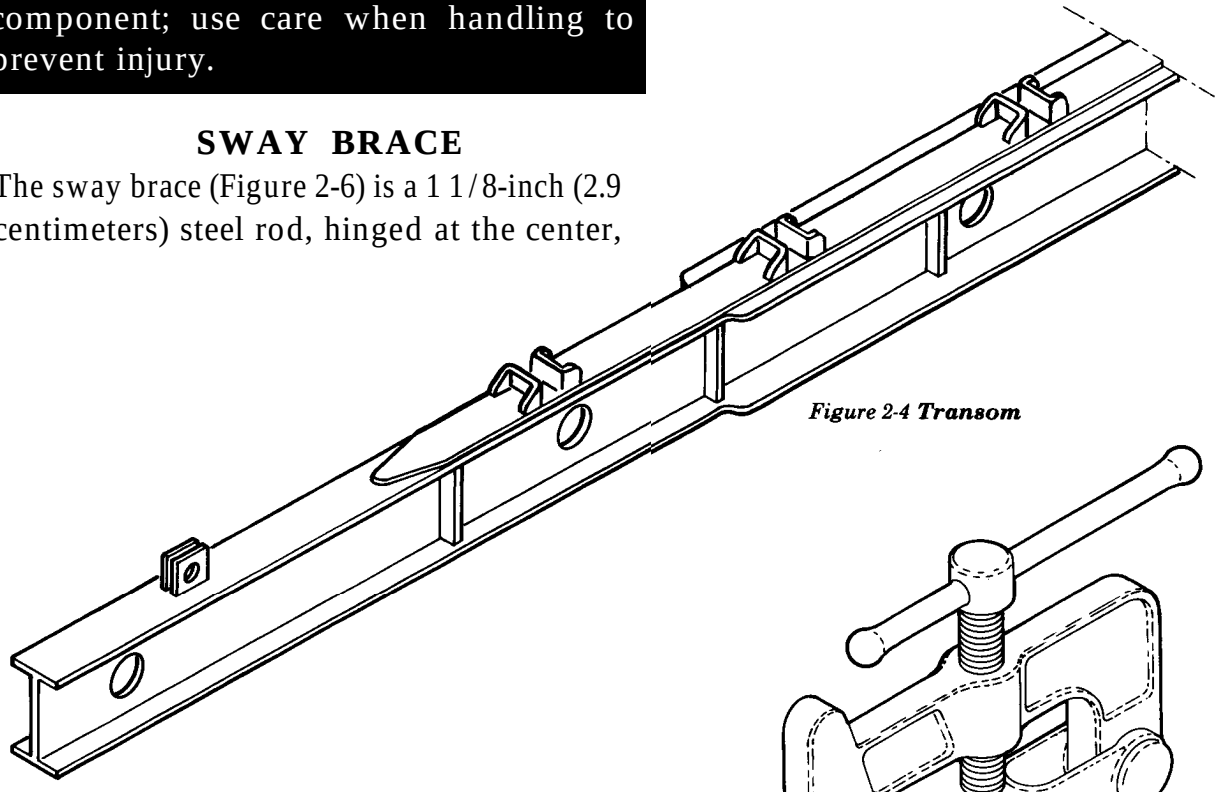


*Figure 2-4 **Transom***

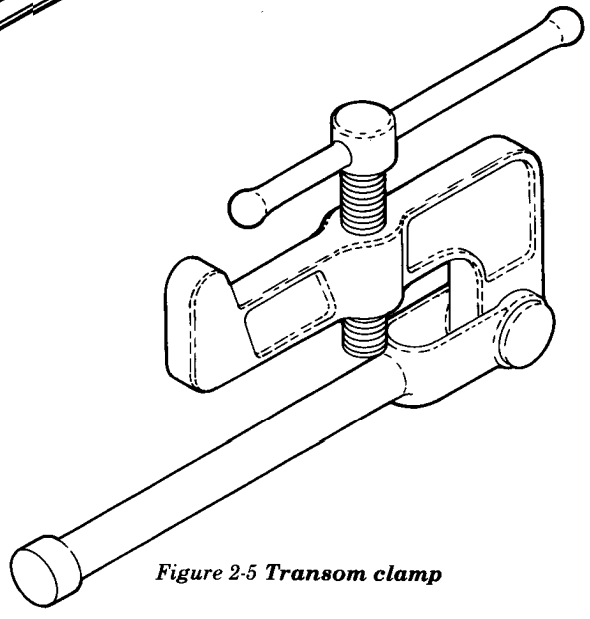


*Figure 2-5 **Transom clamp***

RAKER

The raker (Figure 2-7) is a 3-inch (7.6 centimeters) steel beam with a 2 3/8-inch (6.0 centimeters) flange. It is 3 feet 8 5/16 inches (1.11 meters) long and weighs 22 pounds (10.0 kilograms). A raker connects the ends of the

transom to the top of one end of each panel of the inner truss. This prevents the panels from overturning. An additional raker is used at each end of the bridge. Both ends of the raker have hollow dowels for the bracing bolts. The dowels fit through a hole in the panel and a hole in the transom.

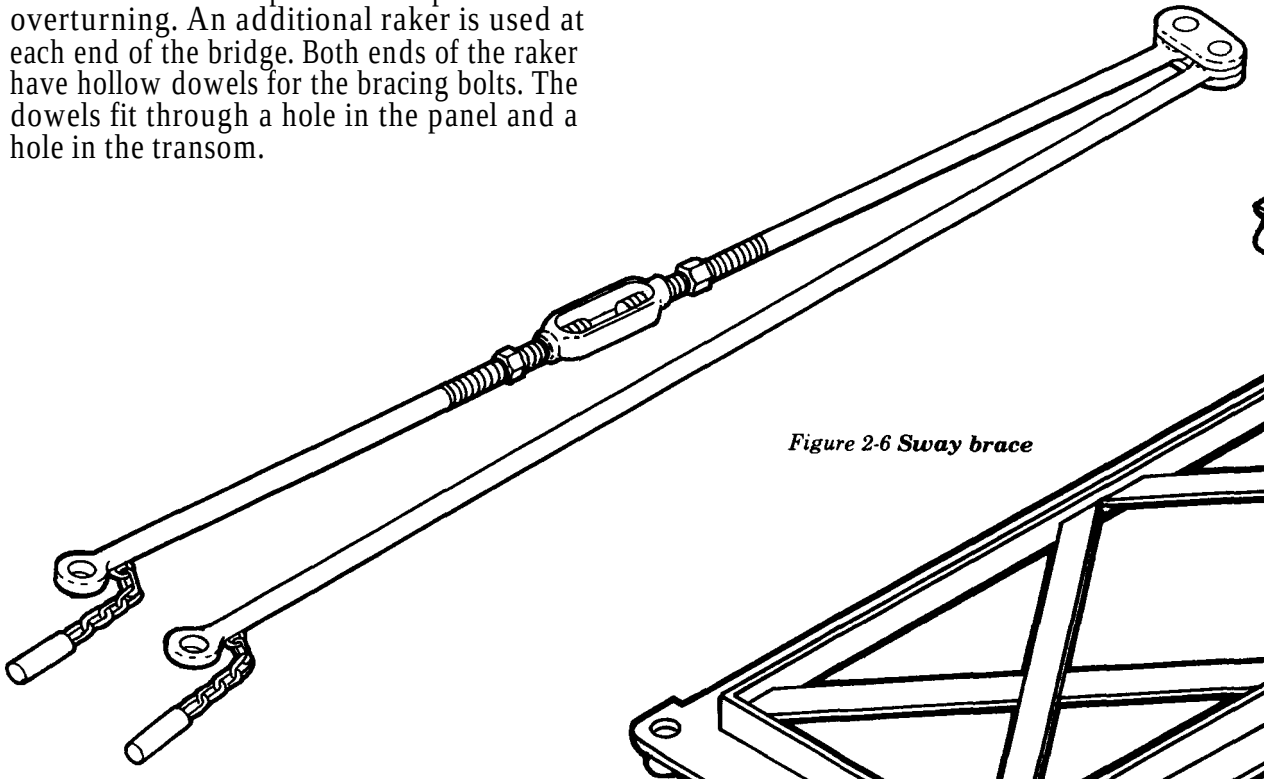


Figure 2-6 ***Sway brace***

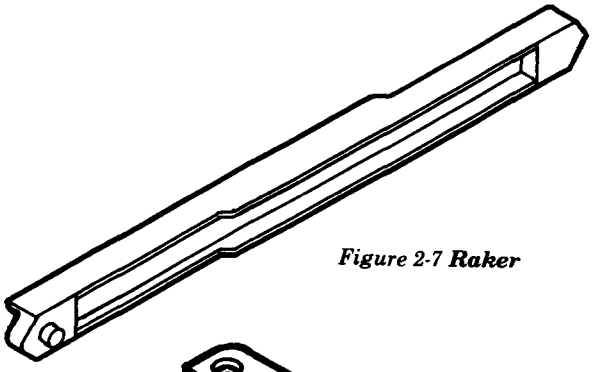


Figure 2-7 ***Raker***

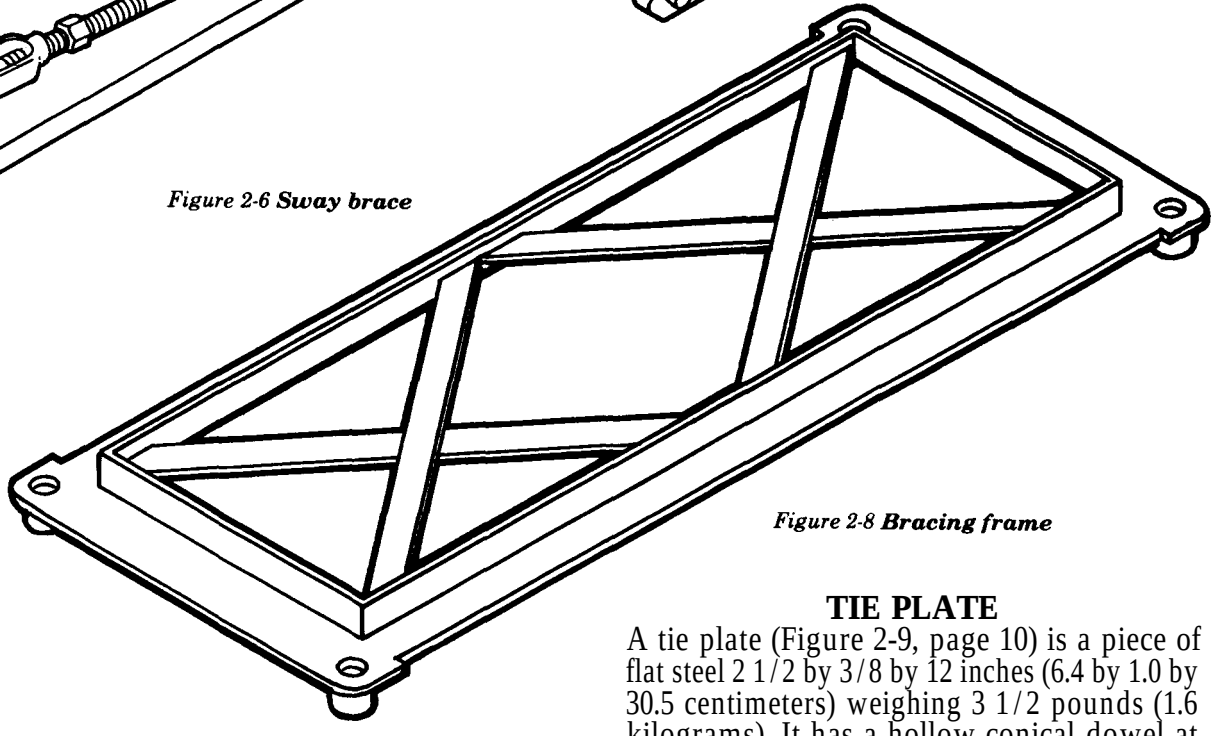


Figure 2-8 ***Bracing frame***

BRACING FRAME

The bracing frame (Figure 2-8) is a rectangular frame, 4 feet 3 inches (1.3 meters) by 1 foot 8 inches (50.8 centimeters) with a hollow conical dowel in each comer. It weighs 44 pounds (20.0 kilograms). The bracing frame is used to brace the inner two trusses on each side of the double- and triple-truss bridge. Bracing bolts attach the bracing frames horizontally to the top chords of the bridge, and vertically on one end of each panel in the second and third stories.

TIE PLATE

A tie plate (Figure 2-9, page 10) is a piece of flat steel 2 1/2 by 3/8 by 12 inches (6.4 by 1.0 by 30.5 centimeters) weighing 3 1/2 pounds (1.6 kilograms). It has a hollow conical dowel at each end. The tie plate is used only in triple-truss bridges. It secures the second truss to the third truss using the unoccupied raker holes in the panels at each joint and at the ends of the bridge.

BRACING BOLT

A bracing bolt (Figure 2-10) is 3/4 inch (1.9 centimeters) in diameter, 3 1/2 inches (8.9 centimeters) long, and weighs about 1 pound (0.5 kilograms). A special lug on its head prevents rotation when the bolt is tightened. A l 1/8inch (2.9 centimeters) wrench is used to tighten it. The bracing bolt is used to attach rakers, bracing frames, and tie plates to panels. It is inserted into the hollow dowels of the braces to draw parts into proper alignment.

CHORD BOLT

A chord bolt (Figure 2-11) is 1 3/4 inches (4.4 centimeters) in diameter, 10 1/2 inches (26.7 centimeters) long, and weighs 7 1/2 pounds (3.4 kilograms). It is tapered through half its length to assist in drawing the panels into alignment. A 1 7/8-inch (4.8 centimeters) wrench is used to tighten the bolt. Chord bolts join the panels, one above the other, to form double and triple-story bridges. Two bolts per panel pass upward through holes in the panel chords and are tightened with nuts on the lower chord of the upper story. They are also used to fasten overhead bracing supports to the top panel chord.

STRINGERS

Stringers (Figure 2-12) carry the bridge's roadway. Each stringer consists of three 4-inch (10.2 centimeters) steel beams, 10 feet (3.0 meters) long, joined by welded braces. There are two types of stringers: plain stringers weighing 260 pounds (118 kilograms) and button stringers weighing 267 pounds (122 kilograms). They are identical except that the latter has 12 buttons which hold the ends of the chess (roadway) in place. Each bay of the bridge has six stringers: four plain stringers in the middle, and a button stringer on each side. The stringers are positioned by the lugs on the top of the transoms.

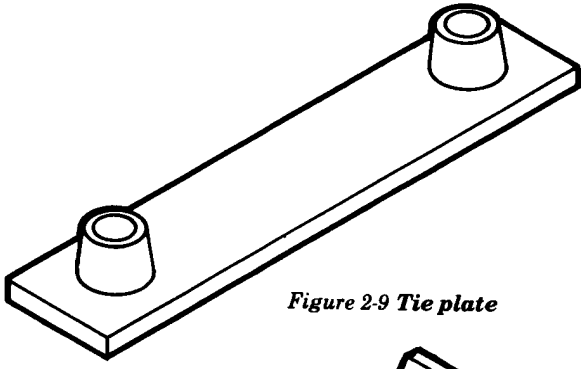


Figure 2-9 ***Tie plate***

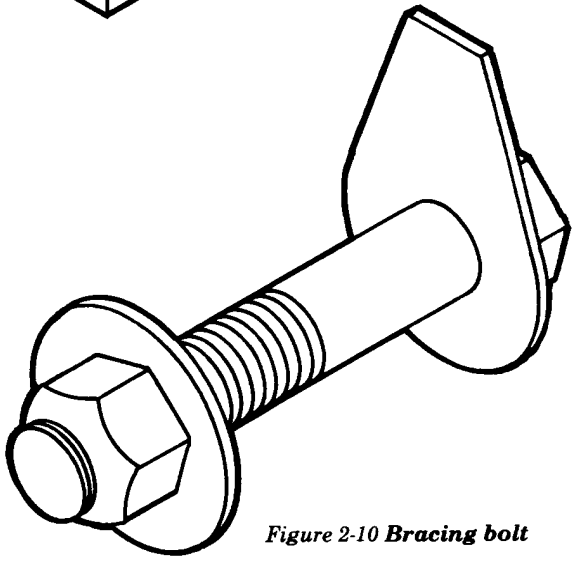


Figure 2-10 ***Bracing bolt***

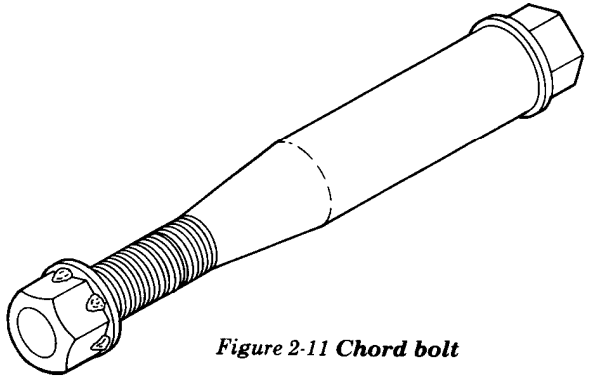


Figure 2-11 ***Chord bolt***

CHESS

Chess (Figure 2-13), often referred to as deck or decking, form the road surface. A piece of chess is 2 inches (5.1 centimeters) by 8 3/4 inches (22.2 centimeters) by 13 feet 10 inches (4.2 meters). It is made of wood and weighs 65 pounds (29.5 kilograms). It is notched at the ends to fit between the buttons of the bottom stringer. Each bay of the bridge contains 13 chess, which lie across the stringers and are held in place by the buttons. Chess are held down by ribbands.

STEEL RIBBAND (CURBS)

A ribband (Figure 2-14) is a metal curb 8 inches (20.3 centimeters) high and 10 feet (3.0 meters) long. It weighs 162 pounds (73.5 kilograms). It is fastened to the button stringers by four J-type ribband bolts.

RIBBAND BOLT

A ribband bolt (Figure 2-15) is a J-type bolt, 1 inch (2.5 centimeters) in diameter and 8 5/8 inches (21.9 centimeters) long. It weighs 4 1/2 pounds (2.0 kilograms). A 1 1/2-inch (3.8 centimeters) wrench is used to tighten it. The ribband bolt fastens the ribband to the button stringers and ramps. The hook end of the bolt grips the lower flange of the outer beam of the button stringer or ramp.

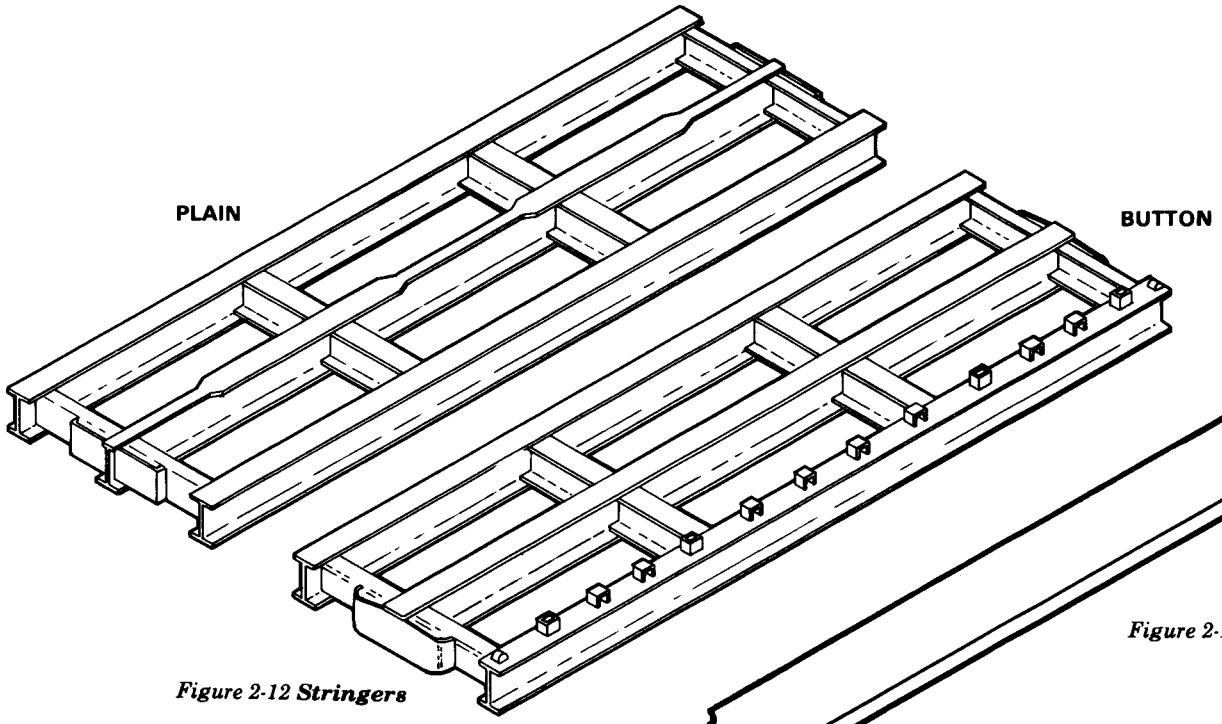


Figure 2-12 ***Stringers***

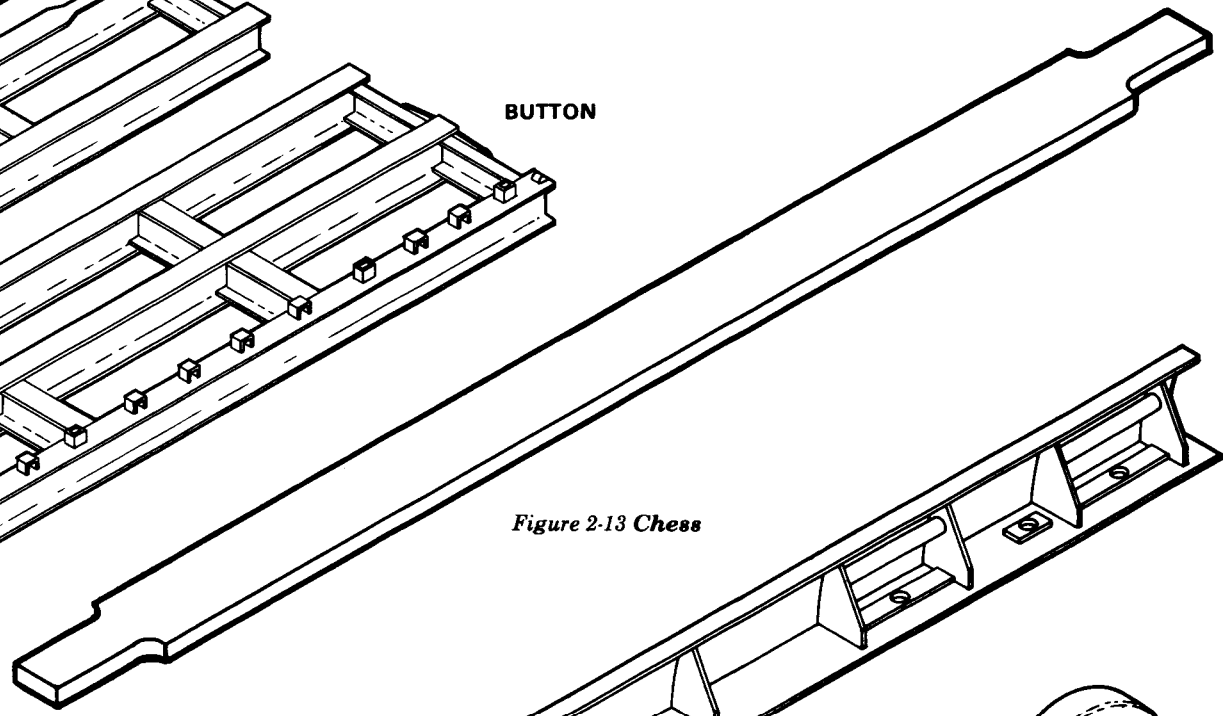


Figure 2-13 ***Chess***

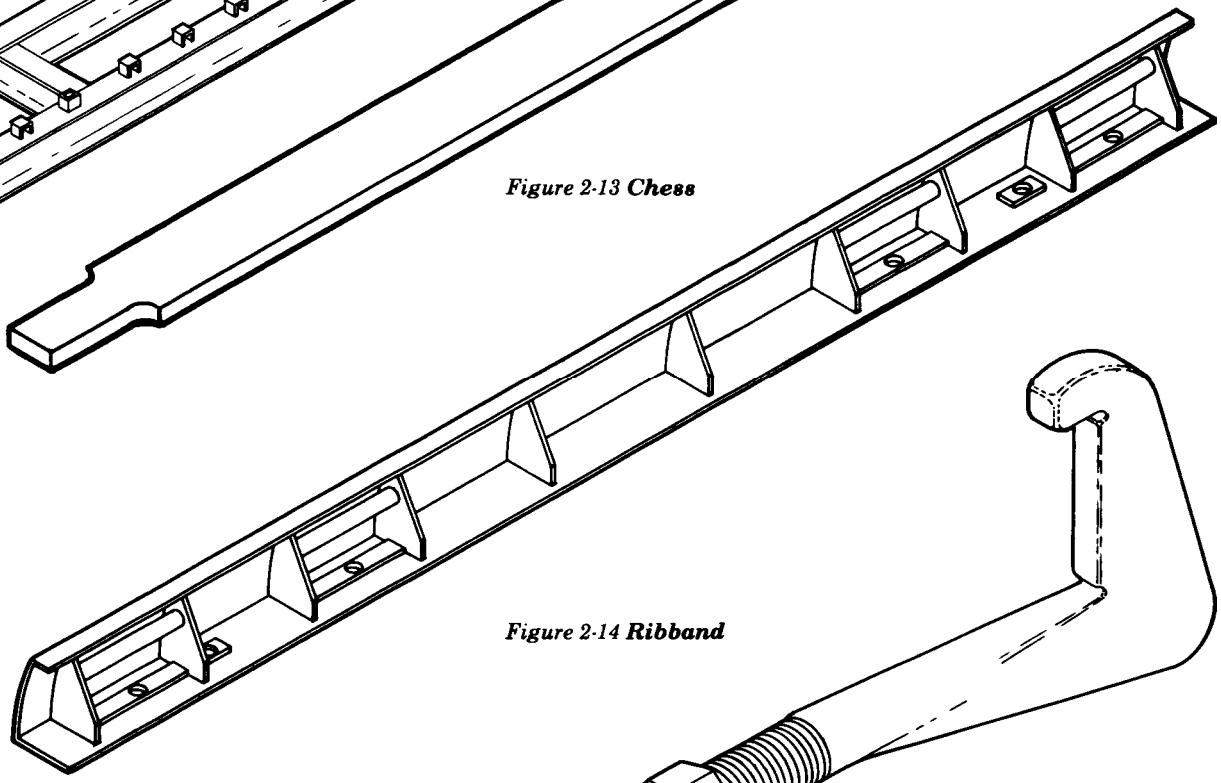


Figure 2-14 ***Ribband***

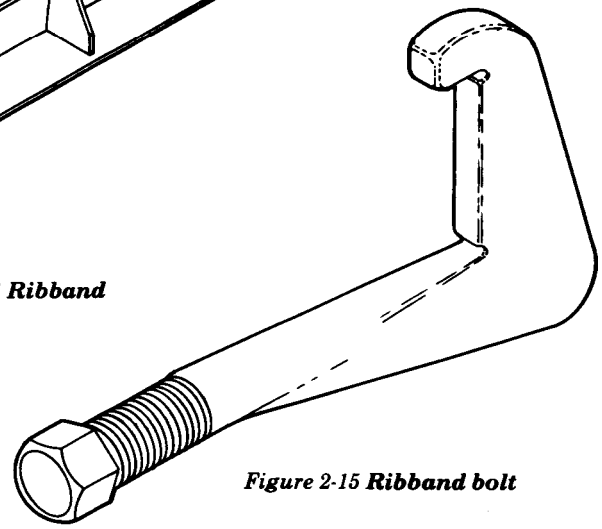


Figure 2-15 ***Ribband bolt***

END POSTS

End posts (Figure 2-16, page 12) are used on both ends of each truss of the bridge to take the vertical shear. They are placed only on the story carrying the decking. They are 5-foot 8-inch (1.7 meters) columns made of two 4-inch (10.1 centimeters) channels and plates welded together. There are two types; male and female, having male and female lugs, respectively. These lugs are secured to the end panels of the bridge by panel pins placed through holes in the lugs. The male and female end posts weigh 121 and 130 pounds (54.9 and 59.0 kilograms), respectively. End posts have a step to support a transom outside

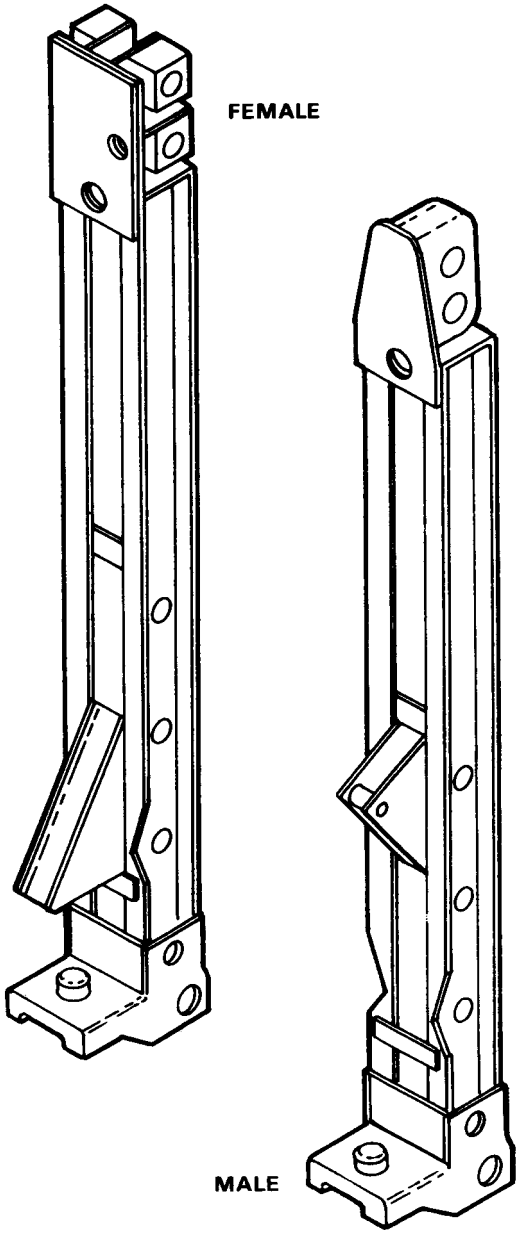


Figure 2-16 ***End posts***

the panel at one end of the bridge. In jacking the bridge, the jack is placed under the step. The lower end of the end post has a bearing block with a semicircular groove which fits over the bearing.

BEARING

The bearing (Figure 2-17) spreads the load of the bridge to the base plate. A bearing is a welded steel assembly containing a round bar which, when the bridge is completed, supports the bearing blocks of the end posts. During assembly of the bridge, it supports the bearing block of the rocking roller (explained later in this chapter). The bar is divided into three parts by two intermediate sections that act as stiffeners. The bearing is 4 5/16 inches (11.9 centimeters) high and weighs 68 pounds (30.8 kilograms). One bearing is used at each corner of a single-truss bridge and two bearings per corner for a double- or triple-truss bridge.

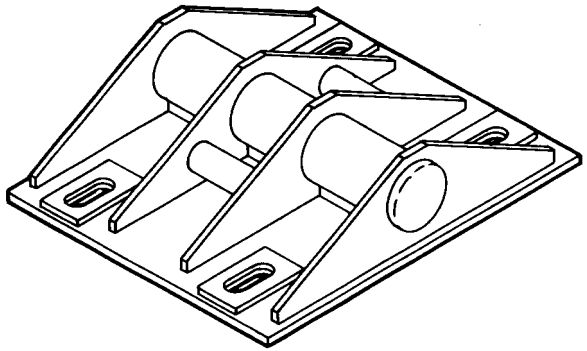


Figure 2-17 ***Bearing***

BASE PLATE

The base plate (Figure 2-18) is a welded steel assembly with built-up sides and lifting-hook eyes on the top at each corner. It is used under the bearings to spread the load from the bearings over the ground or grillage. The bottom surface of the baseplate is 13 1/2 square feet (1.25 meters 2). The base plate weighs 381 pounds (173 kilograms) and is large enough for the bearings at one corner of a single-, double-, or triple-truss bridge. Bearings can slide 9 inches (22.9 centimeters) longitudinally on the baseplate. The numbers 1,2, and 3 are embossed on the edges of the base plate to indicate the position of the plate under the inner truss of single-, double-, and triple-truss bridges respectively.

RAMPS

Ramps (Figure 2-19) are similar to stringers but consist of three 5-inch (12.7 centimeters), instead of 4-inch (10.2 centimeters), steel beams. They are 10 feet (3.0 meters) long and are joined by welded braces. The lower surface of the ramp tapers upward near the ends. There are two types of ramps: plain ramps weighing 338 pounds (153 kilograms), and button ramps weighing 349 pounds (158 kilograms). They are identical except that. the latter have 12 buttons which hold the ends of the chess in place. The ends of the ramps fit into lugs on the transoms at the ends of the bridge.

RAMP PEDESTAL

Ramp pedestals (Figure 2-20) are built-up welded steel assemblies weighing 93 pounds (42.2 kilograms). They prevent the transoms supporting multiple-length ramps from over-

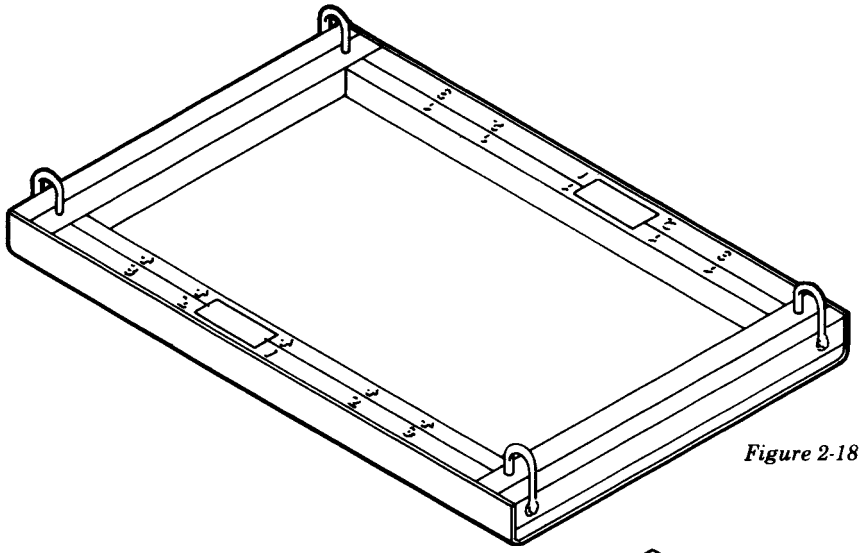


Figure 2-18 ***Base plate***

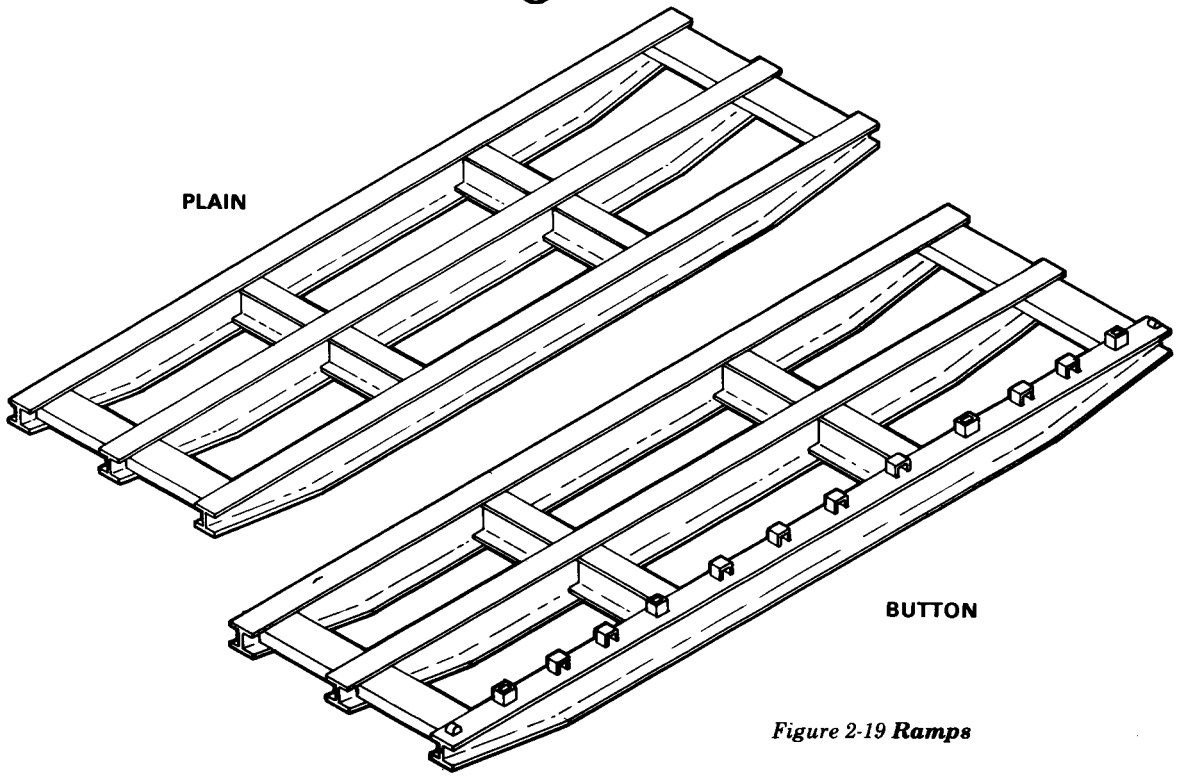


Figure 2-19 ***Ramps***

turning and spread the transom load over the ground. They are held in place by spikes or pickets driven through holes in their base plates.

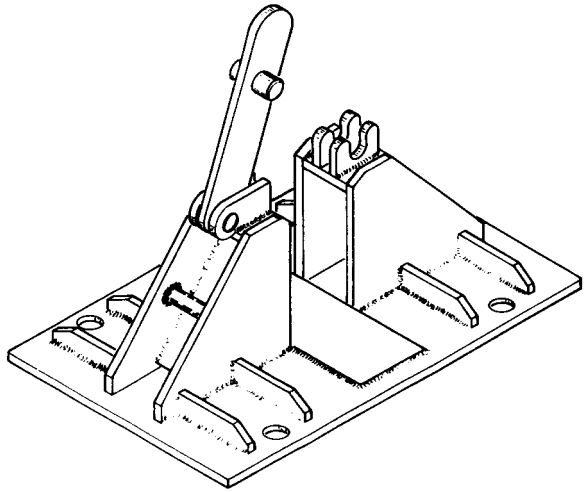


Figure 2-20 ***Ramp pedestal***

FOOTWALK

The footwalk (Figure 2-21, page 14) may be of wood or aluminum. The wood footwalks are 2 feet 6 inches (0.8 meter) wide and 10 feet (3.0 meters) long. The aluminum footwalks are 25 3/4 inches (65.4 centimeters) wide and 9 feet 11 1/2 inches (3.0 meters) long. Supported on footwalk bearers, footwalks are laid along the outer sides of the bridge for use by foot troops.

FOOTWALK BEARER

A footwalk bearer (Figure 2-22) is a built-up beam of pressed steel 4 feet (1.2 meters) long,

weighing 23 pounds (10.4 kilo grams). Bearers are attached to all transoms and hold the footwalk post.

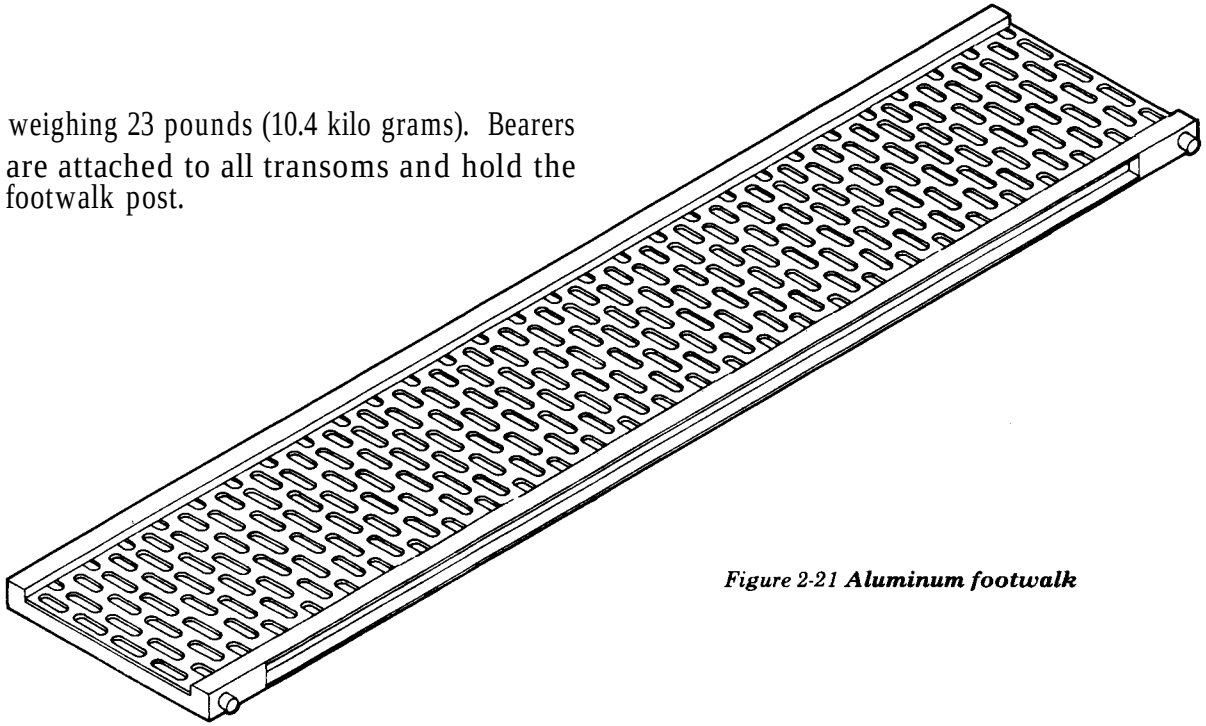


Figure 2-21 ***Aluminum footwalk***

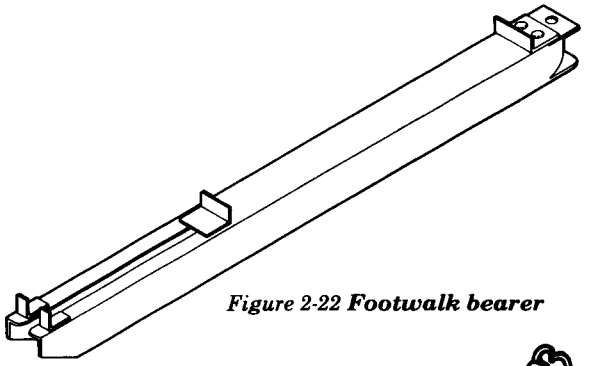


Figure 2-22 ***Footwalk bearer***

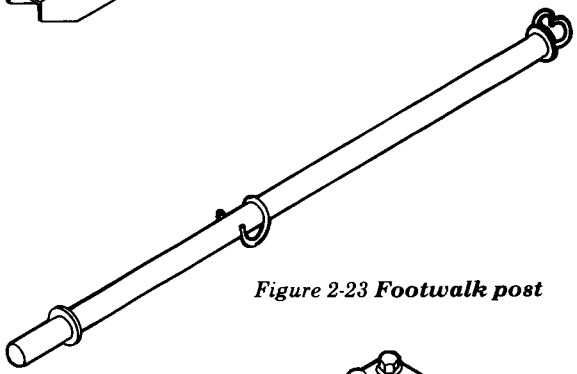


Figure 2-23 ***Footwalk post***

FOOTWALK POST

A footwalk post (Figure 2-23) is 4 feet (1.2 meters) high, weighs 10 pounds (4.5 kilograms), and is fitted into every footwalk bearer. Hand ropes are threaded through two eyes on each post and secured either to holdfasts on the banks or end footwalk posts.

OVERHEAD-BRACING SUPPORT

The overhead-bracing support (Figure 2-24) is used to clamp overhead transoms and sway braces to trusses for overhead bracing of triple-story bridges. The support is a welded metal assembly that weighs 150 pounds (68.0 kilograms). It is fastened to the tops of third-story panels by chord bolts. A transom is seated over the pintles on top of the support and secured by cleats over the lower flange held by four nuts and bolts. One support per girder is placed on each bay of bridge.

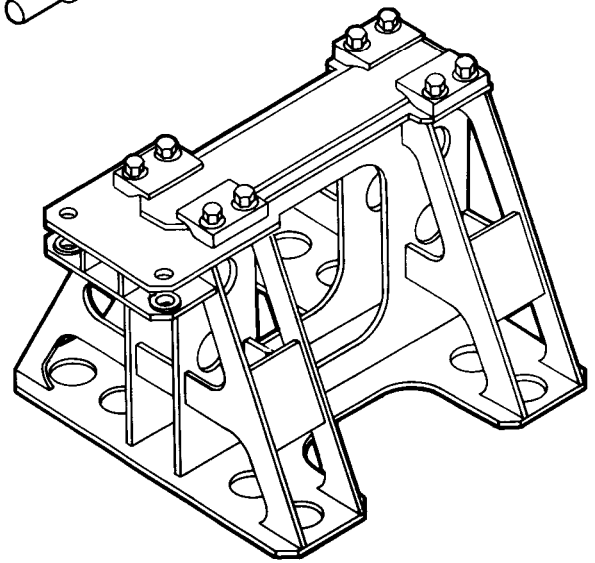


Figure 2-24 ***Overhead-bracing support***

ERECTION EQUIPMENT

ROCKING ROLLER

The rocking roller (Figure 2-25), weighing 206 pounds (93.4 kilograms), consists of three rollers housed in a balanced arm which fits over the bearing, and is free to rock on it. Two side rollers on the flange on each side of the rocking roller frame act as guides for the trusses. The side rollers can be removed from the flanges by removing split pins from spindles underneath the flange; they then remain loosely attached to the frame by a chain. The rollers distribute the bridge load along the bottom chord during launching. The maximum allowable load on one rocking roller is 30 tons (27.2 metric tons).

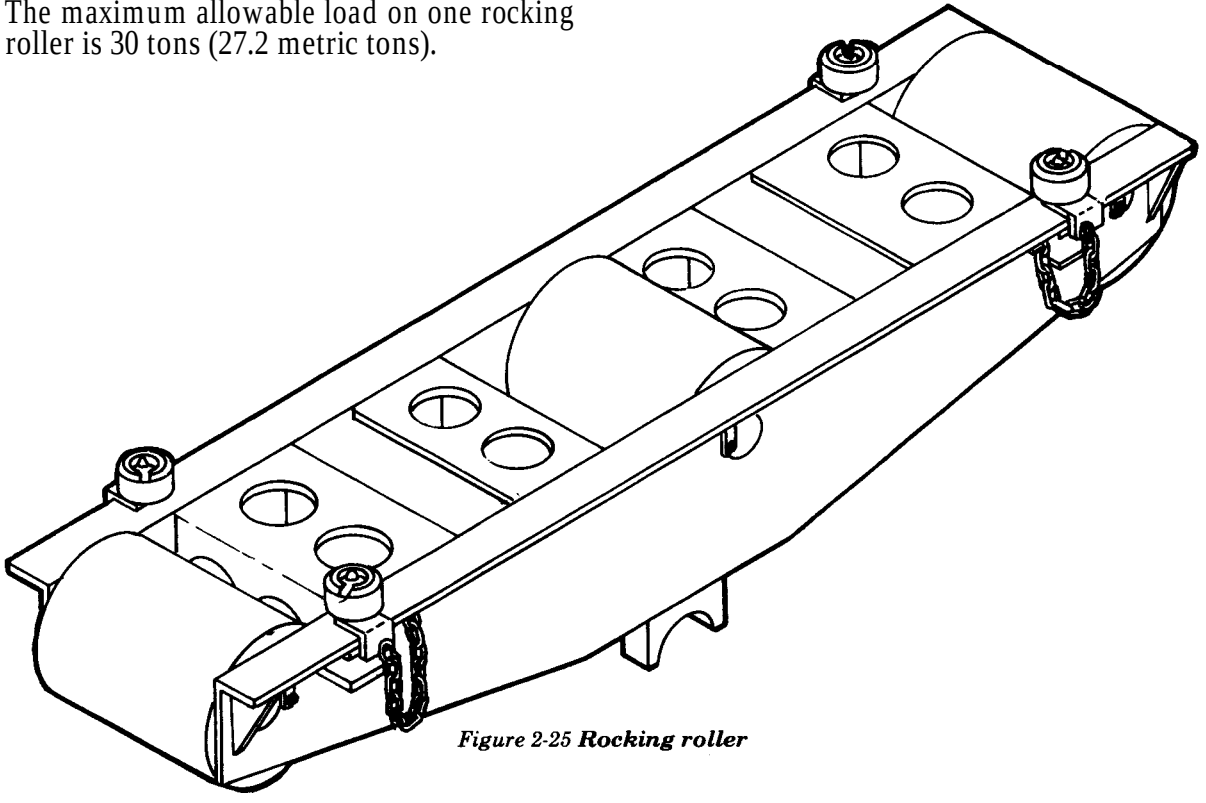


Figure 2-25 ***Rocking roller***

PLAIN ROLLER

The plain roller (Figure 2-26) is 2 feet 1 1/2 inches (64.8 centimeters) wide and weighs 116 pounds (52.6 kilograms). It consists of a welded housing containing a single roller split in two. The maximum allowable load on one roller is 10 tons (9.1 metric tons). Trusses of single-truss bridges can be carried on either half of the roller. Second and third trusses of triple-truss bridges are carried on both halves.

TRANSOM ROLLER

The transom roller (Figure 2-27) is a roller having an outside diameter of about 1 7/8 inches (4.8 centimeters) (or 1 1/2-inches [3.8 centimeters] extra-heavy steel pipe) and a

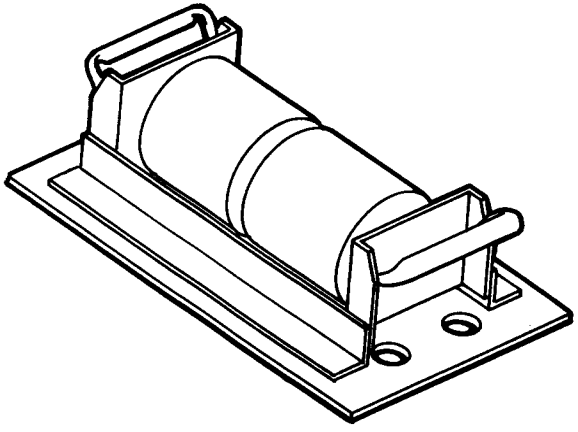


Figure 2-26 ***Plain roller***

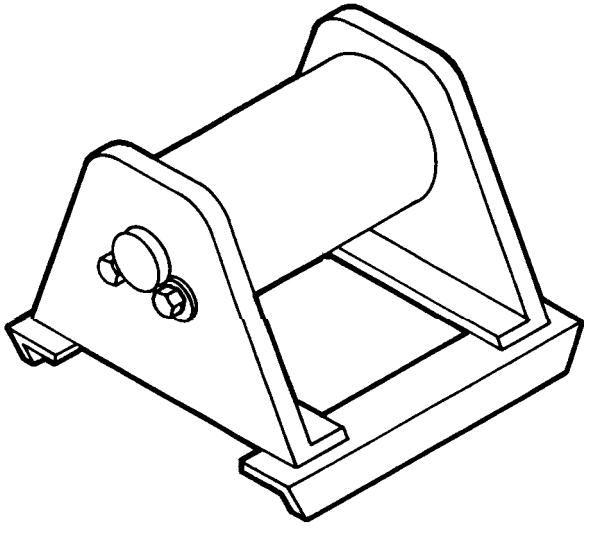


Figure 2-27 ***Transom roller***

length of 6 5/8 inches (16.8 centimeters). The roller is fitted with bronze bushings at each end and revolves on a l-inch (2.5 centimeters) diameter steel pin mounted in a steel frame which is built up from standard steel bars and angles. The roller assembly is 8 inches (20.3 centimeters) long, 7 5/8 inches (19.4 centimeters) wide, and 5 3/4 inches (14.6 centimeters) high overall. It weighs about 12 pounds (5.4 kilograms). The roller is used to make the placement and removal of transoms easier during the assembly and disassembly of the bridge.

WARNING: Two personnel are required on each jack handle to operate jack. These two persons must work together to prevent either from taking all of the load.

JACK

The jack (Figure 2-28) is used to lift the bridge on and off the rocking rollers. It is a mechanical lifting jack (the type normally used in rigging, railroad, and construction work). It has a lifting range of 15 inches (38.1 centimeters) and a capacity on the top of 15 tons (13.6 metric tons). When the weight is carried on its toe, its capacity is only 7 1/2 tons (6.8 metric tons). Jacks from different manufacturers have different spacing (pitch) between the teeth, as listed in Table 2-2. Where jacks are lifting at the same point, all jacks used must have the same tooth pitch so they can be operated in unison. The jack weighs 128 pounds (58.1 kilograms).

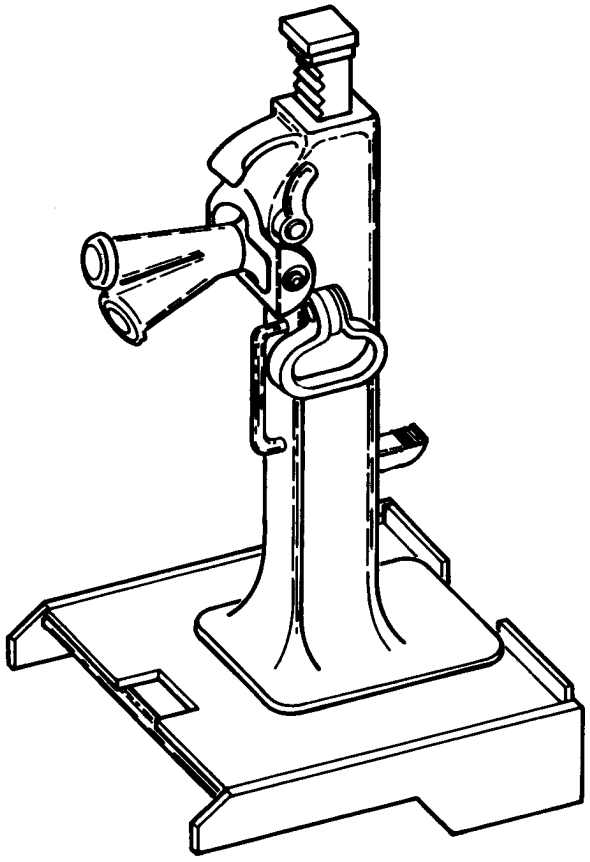


Figure 2-28 ***Jack and jack shoe***

Table 2-2 ***Pitch of teeth in panel-bridge jacks***

MANUFACTURER	MODEL	DISTANCE BETWEEN TEETH (pitch in inches)
Joyce	1928	7/16
Simplex	29	15/32
Buda	2815	5/16
Duff-Norton	2815	5/16

JACK SHOE

The jack shoe (Figure 2-28) is a welded assembly which fits over the bearing and supports the jack. In jacking under the step of the end posts, the bearing can be placed readily without removing the jack shoe. The shoe is 4 3/16 inches (10.6 centimeters) high and weighs 36 pounds (16.3 kilograms). It fits over the bearing on the base plate.

WRENCHES

The wrenches provided in the bridge set are shown and listed in Figure 2-29.

PANEL LEVER

The panel lever (Figure 2-30), used in assembling the second and third trusses after the first truss is in place over the gap, is a wooden bar 7 feet 9 inches (2.4 meters) long weighing 48 pounds (21.8 kilograms). It has a fulcrum near the center and a lifting link at the end. The lifting link has a swiveling crosspiece which can be readily attached to the top of a panel by passing it through the upper chord and turning it. The upper end of the link slides in a slot—the inner end of the slot is used when erecting the second truss, the outer end is used when erecting the third truss. The fulcrum is always placed on the top of the first truss. Two levers per panel are required, with two soldiers operating each lever.

CARRYING BAR AND TONGS

A wooden carrying bar (Figure 2-31) is 3 feet 6 inches (1.1 meters) long and reinforced by a steel band at the middle. It is used to carry panels and transoms. It weighs 8 pounds (3.6 kilograms). Carrying tongs are steel and

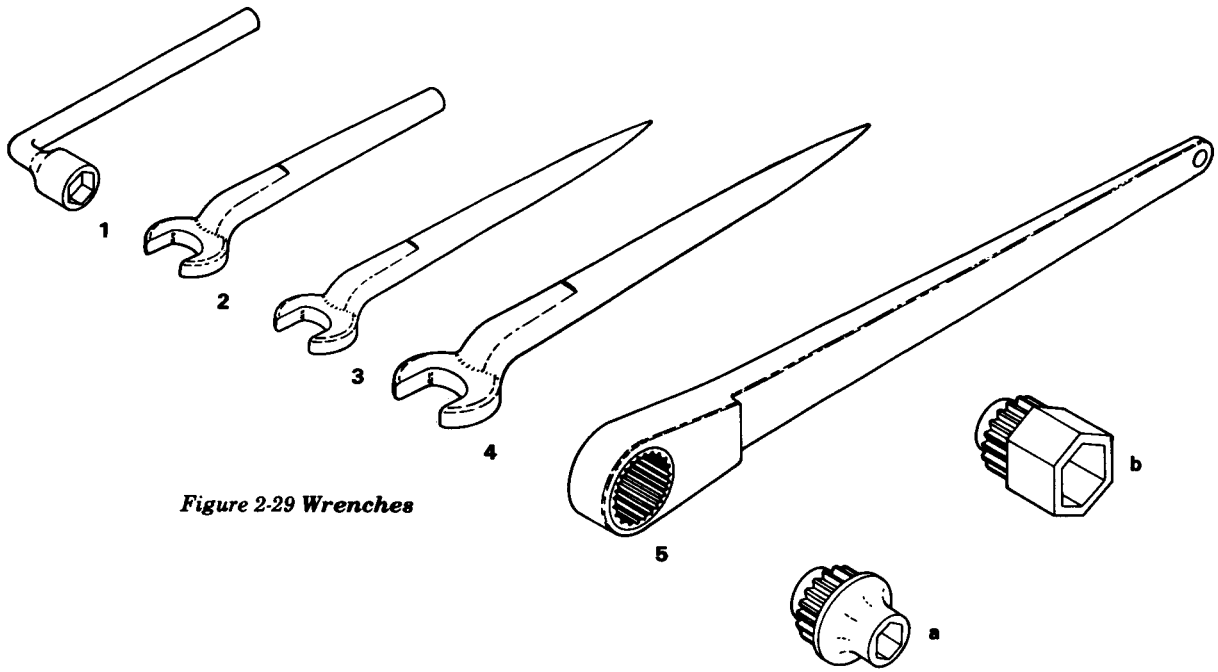


Figure 2-29 ***Wrenches***

WRENCH	USE
1 1⅛" offset 90° socket wrench	Tightening ¾" (bracing) bolts
2 1½" offset structural wrench	Tightening ¾" (bracing, ribband) bolts
3 1½" offset structural wrench	Tightening 1" (sway-brace) lock nut (use tail of wrench for tightening turnbuckle)
4 1⅞" offset structural wrench	Tightening 1¼" (chord) bolts
5 Reversible ratchet-wrench with (a) 1⅞" and (b) 1⅛" sockets	(a) Tightening 1¼" (chord) bolts (b) Tightening ¾" (bracing) bolts

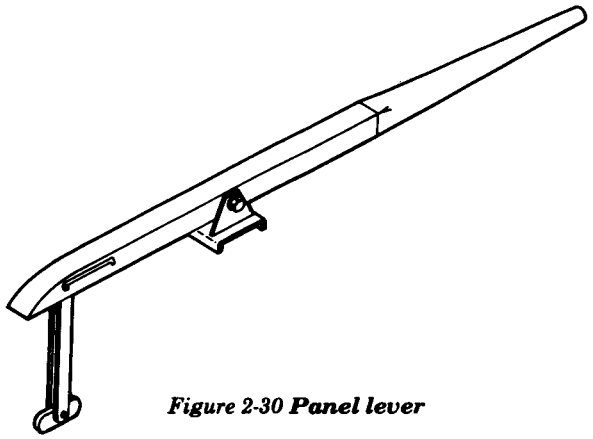


Figure 2-30 ***Panel lever***

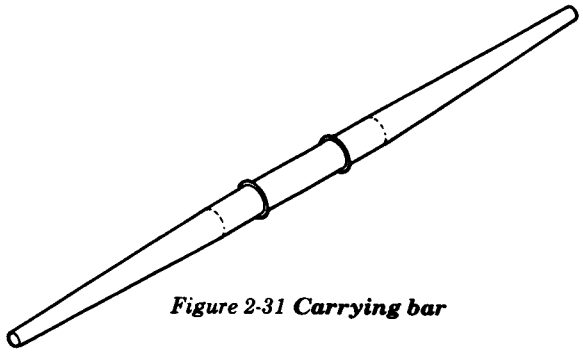


Figure 2-31 ***Carrying bar***

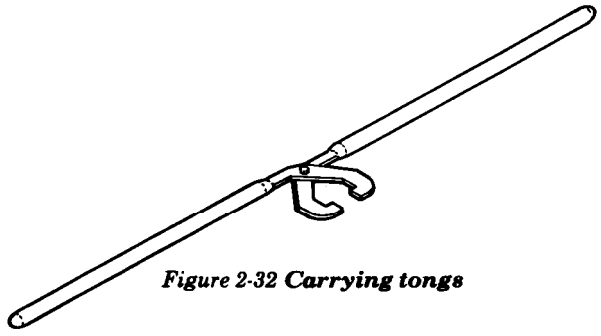


Figure 2-32 ***Carrying tongs***

shaped like railroad tongs, as shown in Figure 2-32. These tongs are used to carry transoms by clamping them over the top flange. One soldier carries one of the two handles. Normally, four pair of tongs and eight soldiers are used to carry a transom.

CHORD JACK

The chord jack (Figure 2-33) consists of two welded steel frames joined by a knuckle-threaded screw assembly. It is operated by a ratchet lever. The lever has a shackle at its end to which a rope can be attached, making operation easier. The chord jack is used to force the panels apart so the chord lug holes align and the chord bolts can be inserted.

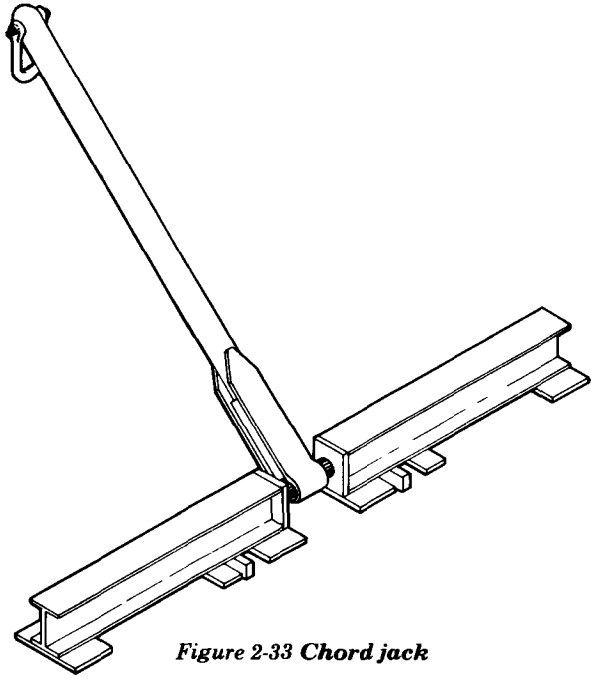


Figure 2-33 ***Chord jack***

PIN EXTRACTOR

The pin extractor (Figure 2-34) assists in dismantling the bridge. After the pin has been driven part way out, and the recess under the head of the pin is exposed, the pin extractor grips the pin head and forces the pin out by a levering action. It is particularly useful for dismantling the third truss of a triple-truss bridge where the closeness of the second truss makes it impossible to drive the pins out with a hammer.

LAUNCHING-NOSE LINK MK II

The launching-nose link Mk II (Figure 2-35) is about 10 inches (25.4 centimeters) long and 7 inches (17.8 centimeters) wide and weighs 28 pounds (12.7 kilograms). It consists of two steel frames welded back to back. The lugs of two panels fit into the link. The sides of the link have holes into which panel pins can be inserted. The links lie flush with the underside of the bottom chords and have a false flange welded on the bottom edge so the bridge can be rolled out on launching rollers. It also has a pintle on the top to seat a transom. Launching-nose links overcome the sag occurring when the launching nose is cantilevered over the gap. They are also used between the upper jaws of span junction posts during the launching of broken-span bridges.

TEMPLATES

Two types of templates are provided, one to locate the bearings for the rocking rollers and the other for the plain rollers. The rocking-roller template (Figure 2-36) weighs 78 pounds (35.4 kilograms) and consists of a timber base with timber strips on top forming two spaces large enough for rocking-roller bearings. At one end of the template are two angle cleats which are used as measuring points. The plain-roller template (Figure 2-37) weighs 22 pounds (10.0 kilograms). It consists of a timber base with timber strips on three sides and a steel strip on the fourth. The strips surround a space large enough for the base-of a single plain roller. The template also has two angle cleats at one end for measuring points.

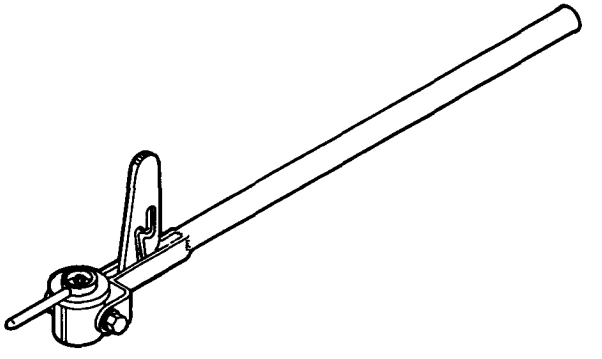


Figure 2-34 ***Pin extractor***

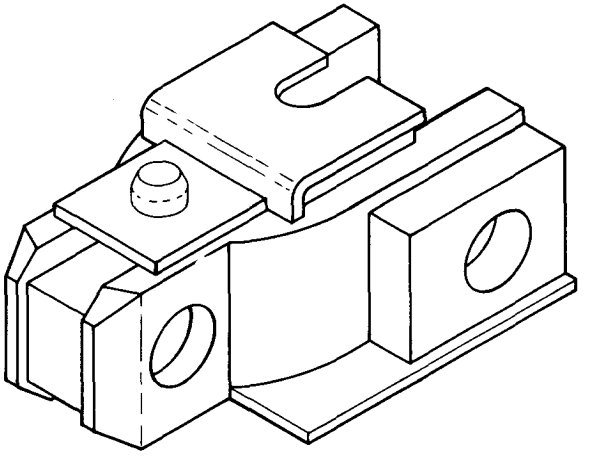


Figure 2-35 ***Launching-nose link Mk II***

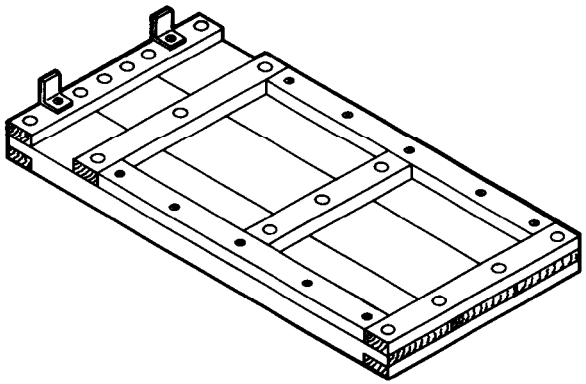


Figure 2-36 ***Rocking-roller template***

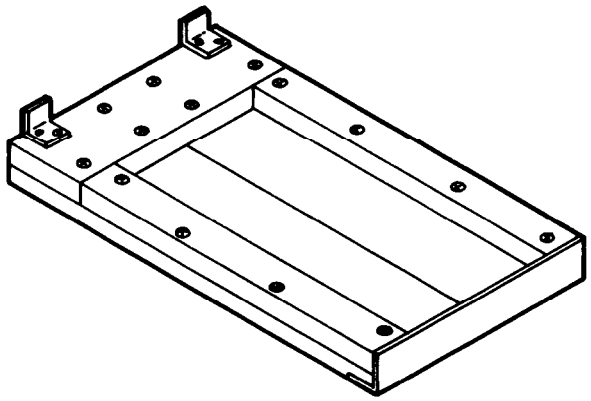


Figure 2-37 ***Plain-roller template***

BRIDGING TRUCK LOADS

BASIC BRIDGE SET

Parts for standard truck loads are drawn from these basic sets. Tables A-2 and A-3 in Appendix A list components of the M2 panel bridge basic set. The set contains enough parts. and equipment to install two 80-foot (24.4 meters) *double-single* M2 bridges with launching nose or one 130-foot (39.0 meters) *double-double* bridge with launching nose.

Conversion Set No. 3, Panel Crib Pier, M2 is used with equipment from the basic set to build panel crib piers. Table A-4 in Appendix A lists component parts of conversion set No. 3. Enough parts are issued with each of these sets to provide the assembly of a triple-truss pier supporting two triple-truss broken spans and containing both horizontal and vertical stories.

RECOMMENDED BRIDGING LOADS

The engineer company (panel bridge) normally transports one set of the Bailey bridge on 5-ton dump trucks and 4-ton bolster trailers. The company has two platoons, each capable of transporting one 80-foot (24.4 meters) bridge (the most common bridge installed). The loads shown in Figures 2-38 through 2-47 and Tables 2-3 through 2-13 (pages 20 through 30) have the following features:

- All loads are within the rated capacity of the assigned vehicles.
- The loading lends itself to stockpiling or assembly on a restricted site. A launching nose can be started with only three loads on the site.
- The number of trailers is 40 percent of the number of trucks. This makes it possible to use trucks to tow trailers if necessary.
- Erection equipment is spread over four trucks and one trailer, thereby minimizing the effect of loss or breakdown.
- Trucks are loaded with all the female or all the male panel ends toward the rear of the vehicles.
- Steel cables are used for tiedowns on all truckloads.

Table 2-3 ***Truck load No. 1—parts and grillage load (5-ton truck)****—(1 load per bridge platoon; 2 loads per company)*

QUANTITY	ITEM	WEIGHT (lb) UNIT	TOTAL
4	Block, double, for ¾" rope	8	32
2	Block, triple, for 1" rope	20	40
2	Block, snatch, for ¾" rope	6.3	13
2	Box, wood	60	120
2	Extractor, pin	18	36
5	Hammer, rubber-faced	4	20
2	Jack, ratchet-lever, 15-ton	128	256
2	Jack, chord	82	164
4	Lever, panel	48	192
24	Lumber, 3" x 6" x 4'6"	18	432
72	Lumber, 6" x 6" x 4'6"	52	3,744
50	Marker, self-luminous	0.13	7
100 lb	Nail, wire, steel		100
6	Pickets, steel	12	72
19	Pin, connector, panel, $7^{9}/_{16}$"	5.8	110
21	Plate, tie	3.5	74
4	Plate, base, bearing	381	1,524
4	Roller, plain	116	464
4	Roller, rocking	206	824
2	Roller, transom	12	24
8	Shoe, bearing, $4^{15}/_{16}$"	68	528
4	Shoe, jack	36	144
4	Sledge, blacksmith, 8-lb	8	32
2	Sign box, interior-illuminated, electric	6	12
10	Spike, ⅜" x 8"		10
4	Template, rocking-roller	78	312
6	Template, plain-roller	22	132
8	Tongs, carrying	13	104
2	Wire rope assembly	12	24
6	Wrench, ratchet, reversible	13	78
8	Wrench, socket, offset 90°	12	96
12	Wrench, structural, 1⅛" for ¾" bolts	2	24
6	Wrench, structural, 1½" for 1" bolts	4.7	27
8	Wrench, structural, 1⅞" for 1¼" bolts	5.6	45
	Total		9,816

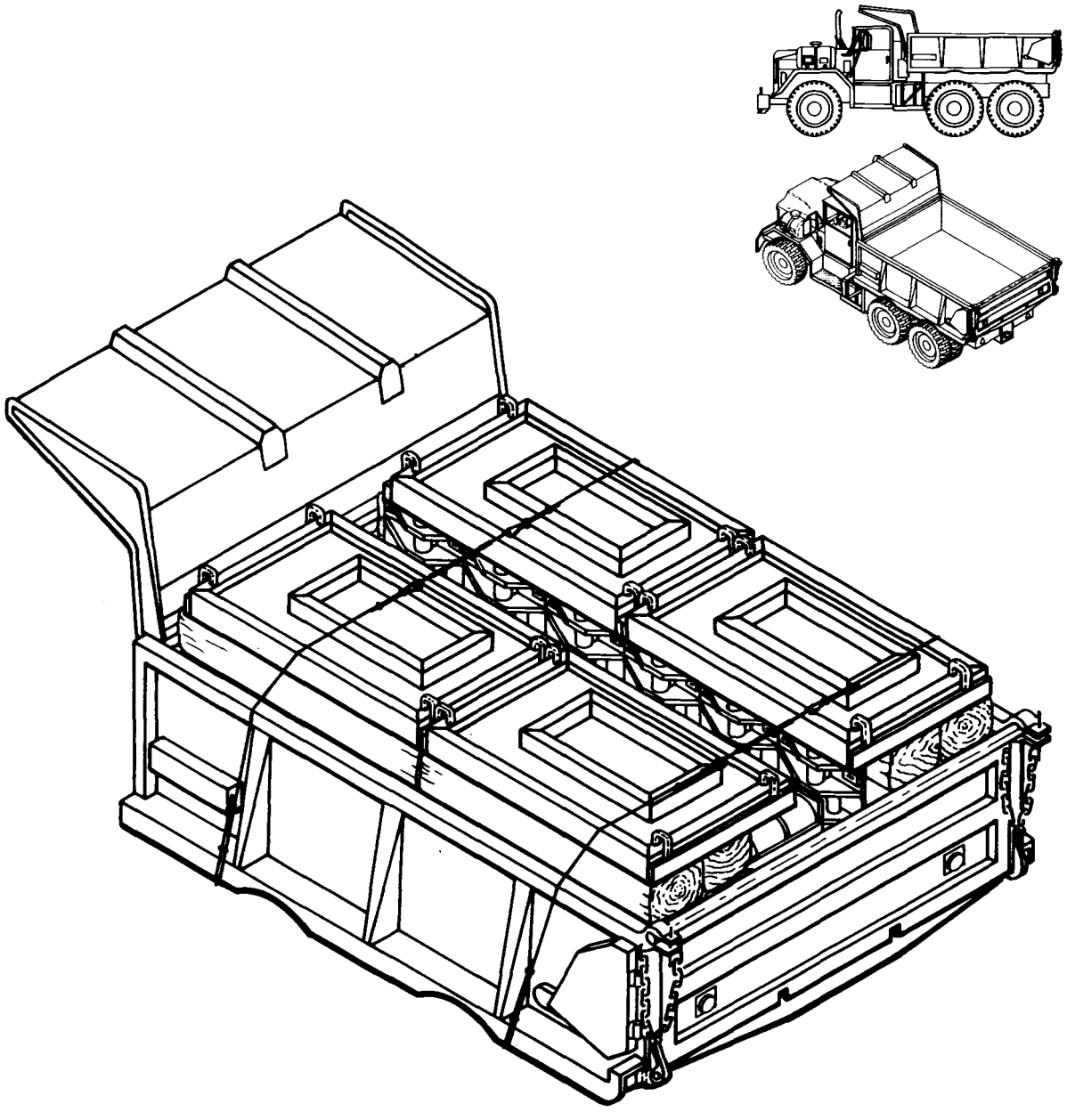


Figure 2-38 ***Truck load number 1—parts and grillage load on 5-ton truck***

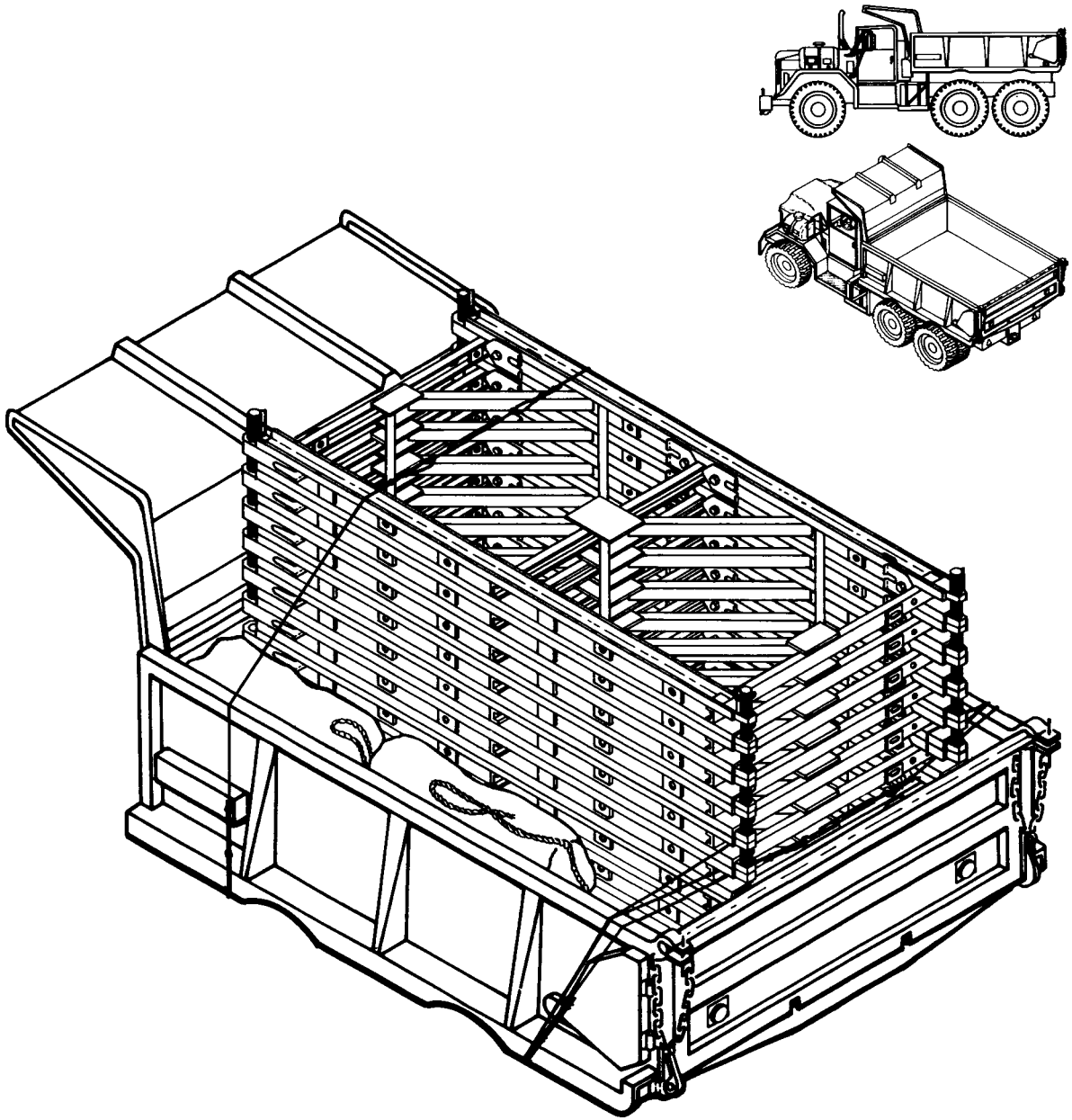


Figure 2-39 ***Truck load number 2—launching-nose load on 5-ton truck***

Table 2-4 ***Truck load No. 2—launching-nose load (5-ton truck)—(1 load per bridge platoon; 2 loads per company)***

QUANTITY	ITEM	WEIGHT (lb) UNIT	TOTAL
3	Bag, Bailey bridge parts and tools	2	6
3	Bar, carrying	8	24
80	Bolt, bracing, bridge	1	80
26	Bolt, connector, chord	7.5	195
8	Brace, sway	68	544
40	Clamp, transom	7	280
65	Clip, retainer, steel	0.13	8.5
2	Hammer, rubber-faced	4	8
12	Link, launching-nose Mk II	28	336
9	Panel, truss, bridge	577	5,193
2	Picket, steel	12	24
30	Pin, connector, panel, $8^{15}/_{16}$"	6.1	183
10	Raker, side, strut	22	220
6	Wrench, ratchet, reversible with 1⅛" and 1⅞" sockets, for ¾" and 1¼" bolts	13	78
8	Wrench, socket, offset 90° 1⅛" for ¾" bolts	12	96
12	Wrench, structural, 1⅛" for ¾" bolts	2	24
6	Wrench, structural, 1½" for 1" bolts	4.7	28
8	Wrench, structural, 1⅞" for 1¼" bolts	5.6	45
	Total		7,373

Note:
One transom load No. 4 is towed by each launching-nose load

Table 2-5 ***Truck load No. 3—panel load (5-ton truck)****—(6 loads per bridge platoon; 12 loads per company)*

QUANTITY	ITEM	WEIGHT (lb) UNIT	TOTAL
3	Bags, Bailey bridge parts and tools	2	6
3	Bar, carrying	8	24
30	Bolt, ribband, guardrail J	4.5	135
80	Bolt, bracing, bridge	1	80
26	Bolt, connector, chord	7.5	195
4	Brace, sway	68	272
40	Clamp, transom	7	280
65	Clip, retainer, steel	0.12	8.5
4	Frame, bracing, bridge	44	156
2	Hammer, rubber-faced	4	8
9	Panel, truss, bridge	577	5,193
2	Picket, steel	12	24
26	Pin, connector, panel, $8^{15}/_{16}$"	6.1	159
4	Raker, side, strut	22	88
4	Ribband, guardrail	162	648
	Total		7,277

Notes:
1. One load carries sufficient panels for two bays of DS bridge
2. Ribband is carried on four trucks/platoon
3. One truck/company carries no rakers or carrying bars
4. Each panel load tows a transom load

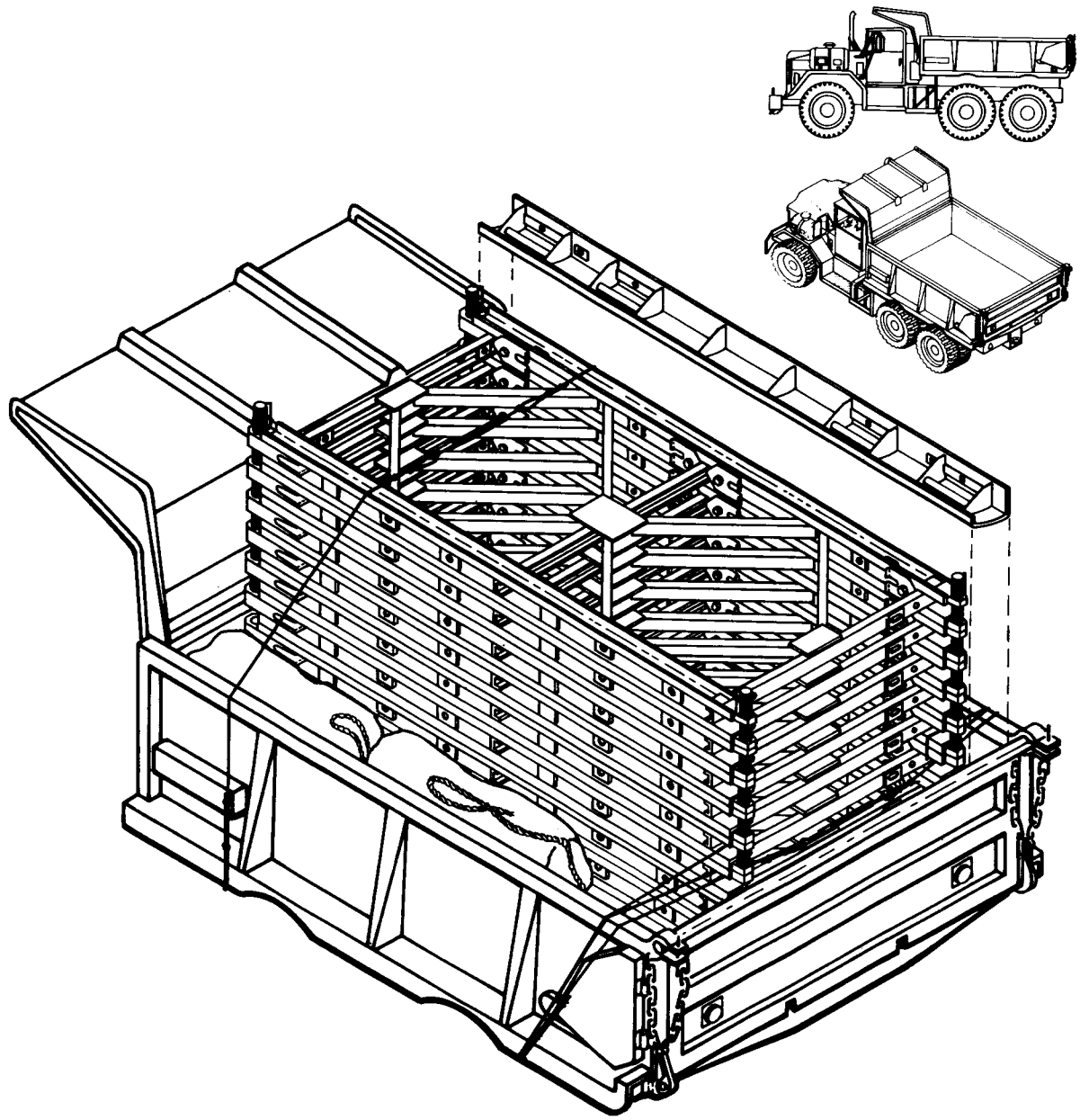


Figure 2-40 ***Truck load number 3—panel load on 5-ton truck***

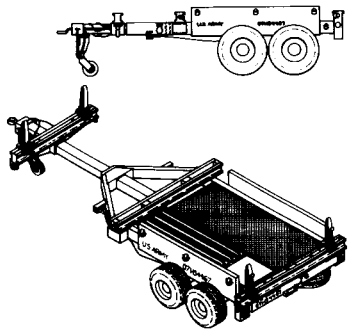


Table 2-6 ***Trailer load No. 4—transom load (4-ton bolster trailer)****—(4 loads per bridge platoon; 8 loads per company)*

QUANTITY	ITEM	WEIGHT (lb) UNIT	WEIGHT (lb) TOTAL
7	Transom, trestle	618	4,326
	Total		4,326

Note:
Ensure that tongue of trailer is extended to its maximum length to allow for easy turning of truck/trailer combination

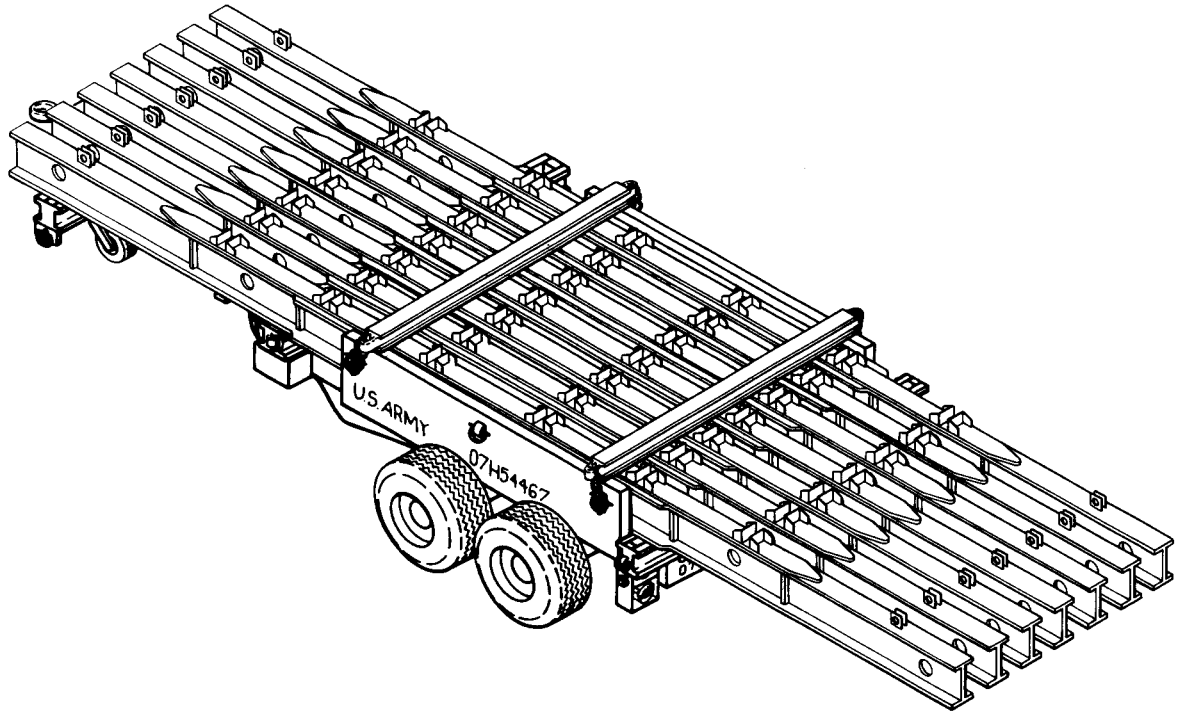


Figure 2-41 ***Trailer load number 4—transom load on 4-ton bolster trailer***

Table 2-7 ***Truck load No. 5—deck load (5-ton truck)—****(2 loads per bridge platoon; 4 loads per company)*

QUANTITY	ITEM	WEIGHT (lb) UNIT	WEIGHT (lb) TOTAL
52	Chess, M2	65	3,380
2	Frame, bracing, bridge	44	88
8	Stringer, button	267	2,136
16	Stringer, plain	260	4,160
	Total		9,764

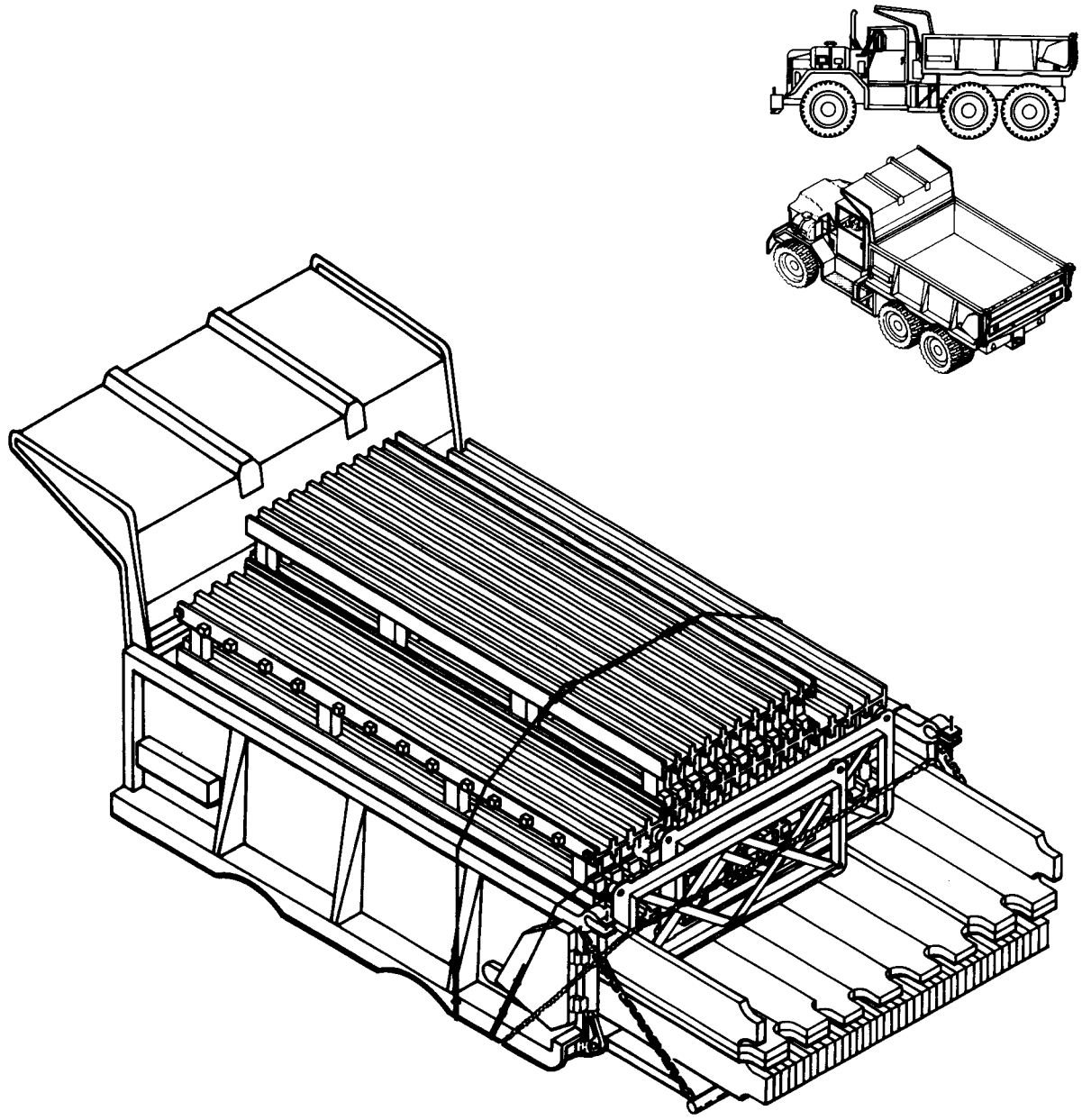
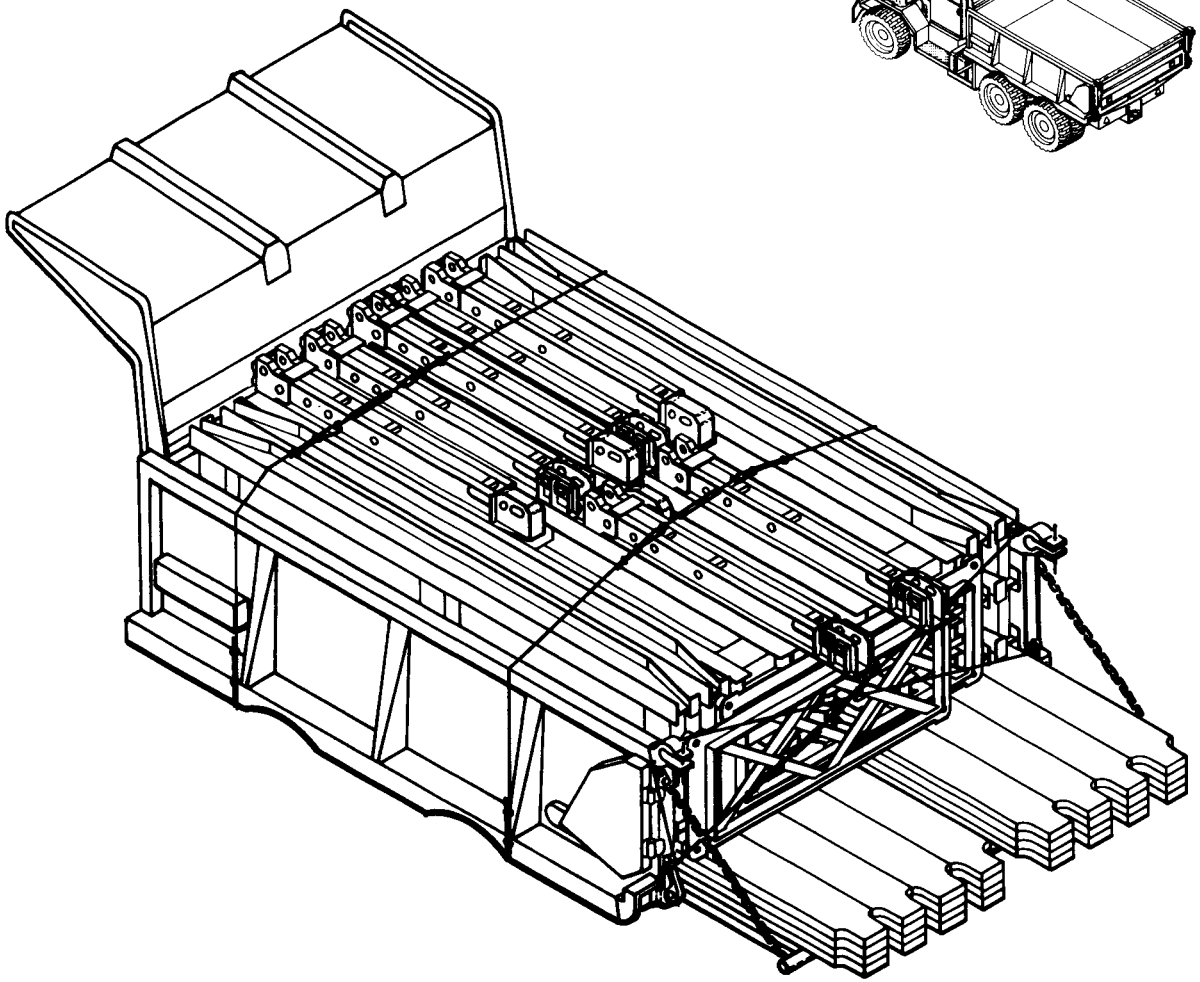


Figure 2-42 ***Truck load number 5—deck load on 5-ton truck***



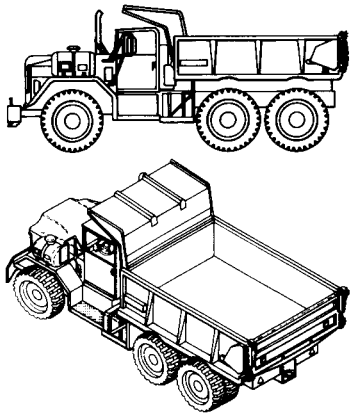


Figure 2-43 ***Truck load number 6—ramp load on 5-ton truck***

Table 2-8 ***Truck load No. 6—ramp load (5-ton truck)****—(2 loads per bridge platoon; 4 loads per company)*

QUANTITY	ITEM	WEIGHT (lb)	
		UNIT	TOTAL
2	Bag, Bailey bridge parts and tools	2	4
20	Bolts, ribband, guardrail J	4.5	90
32	Chess, M2	65	2,080
2	Frame, bracing, bridge	44	88
2	Jacks, ratchet-level, 15-ton	128	256
4	Pedestal, ramp	93	372
4	Post, end, female	130	520
4	Post, end, male	121	484
4	Ramp, button	348	1,392
8	Ramp, plain	338	2,704
4	Ribband, guardrail	162	648
4	Wedge, wood	12	48
	Total		8,686

Table 2-9 ***Trailer load No. 7—footwalk load (4-ton bolster trailer)****—(1 load per bridge platoon; 2 loads per company)*

QUANTITY	ITEM	WEIGHT (lb)	
		UNIT	TOTAL
40	Bearer, footwalk	23	920
16	Footwalk	104	1,664
40	Post, footwalk	10	400
2	Rope, sisal ⅝" x 150", handrail	20	40
	Total		3,024

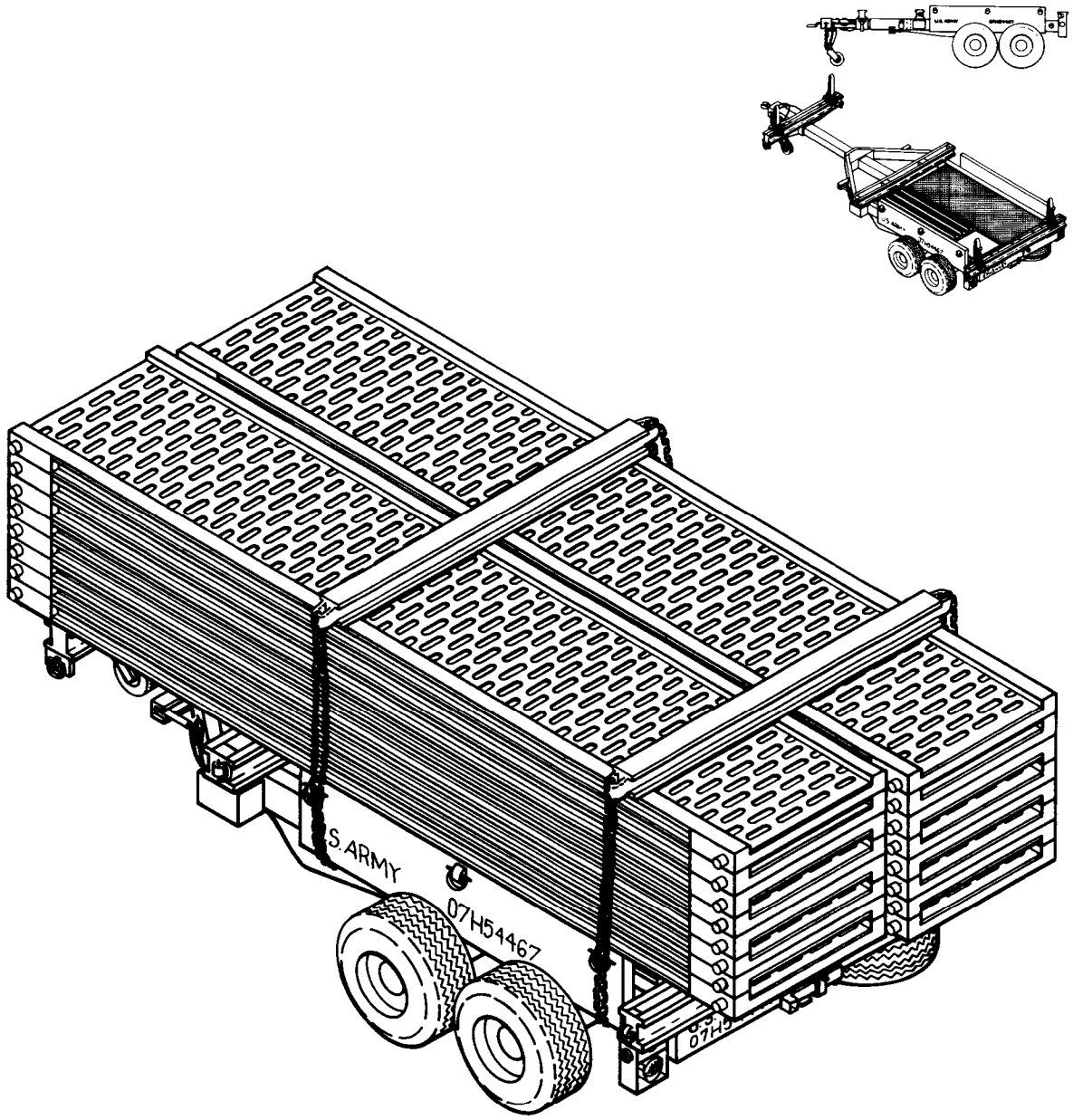


Figure 2-44 ***Trailer load number 7—footwalk load on 4-ton bolster trailer***

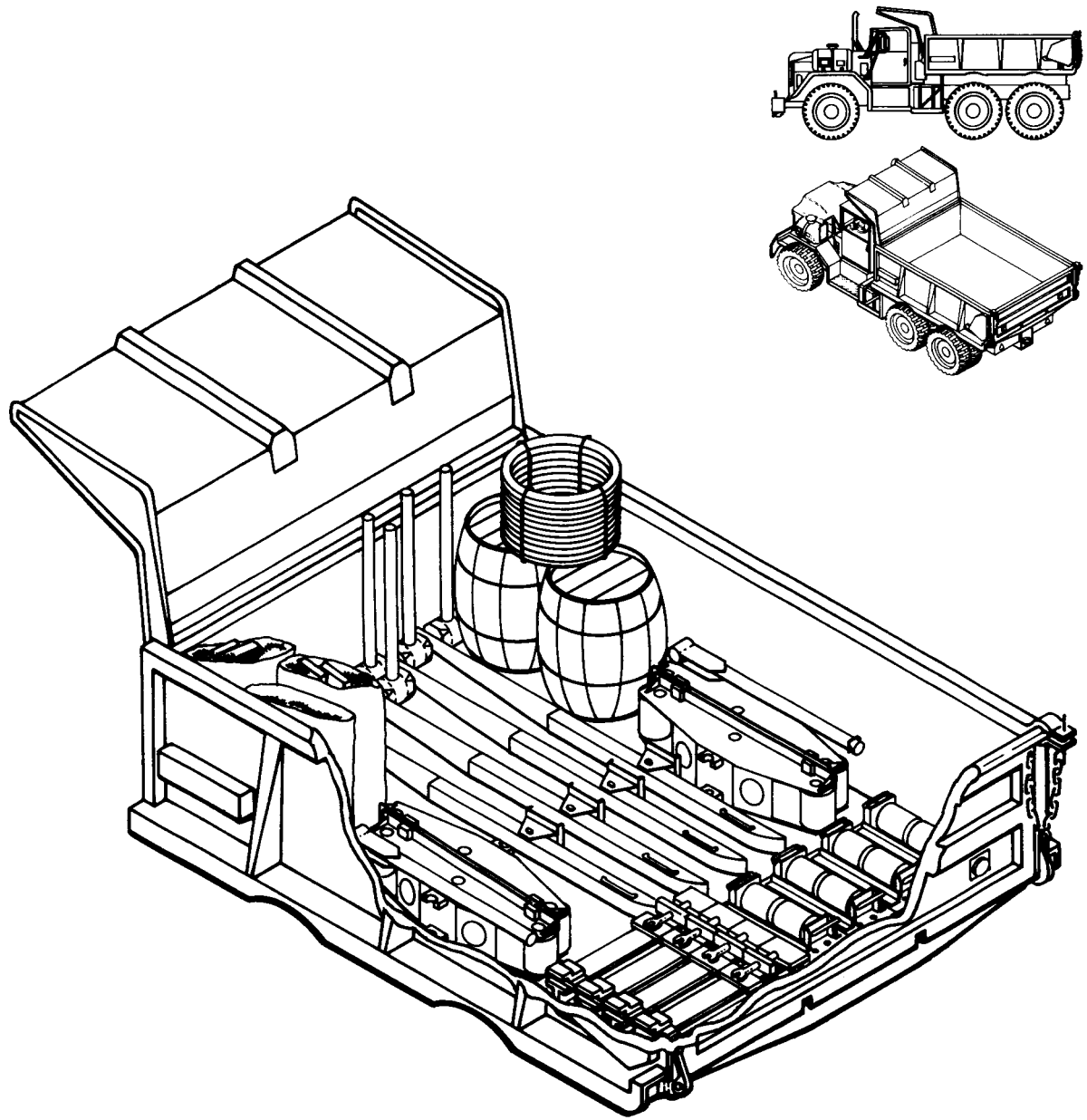


Figure 2-45 ***Truck load number 8—spares load on 5-ton truck***

Table 2-10 ***Truck load No. 8—spares load (5-ton truck)—****(1 load per headquarters platoon; 1 load per company)*

QUANTITY	ITEM	WEIGHT (lb)	
		UNIT	TOTAL
1	Bar, carrying	8	8
80	Bolt, bracing, bridge	1	80
36	Bolt, connector, chord	7.5	270
24	Bolt, end-post, spares	0.75	18
40	Clamp, transom	7	280
90	Clip, retainer, steel	0.13	12
7	Hammer, rubber-faced	4	28
12	Holdfast, w/9 pickets	160	1,920
8	Jack, chord	82	656
4	Lever, panel	48	192
100 lb	Nail, wire, steel		100
28	Pin, connector, panel, $8^{15}/_{16}$"	6.1	171
50	Pin, sway-brace	1.1	55
4	Roller, plain	116	464
4	Roller, rocking	206	824
2	Rope, sisal, ¾" x 600"	102	204
2	Rope, sisal, 1" x 600"	156	312
88	Rope, sisal, lashing, ⅝" x 25"	3.3	290
4	Shackle, anchor-type	5	20
4	Sledge, blacksmith, 8-lb	8	32
4	Tongs, carrying, bridge-erection	13	42
6	Wrench, ratchet, reversible	13	78
8	Wrench, socket, offset 90°	12	96
12	Wrench, structural, 1⅛" for ¾" bolts	2	24
6	Wrench, structural, 1½" for 1" bolts	4.7	29
8	Wrench, structural, 1⅞" for 1¼" bolts	5.6	45
	Total		6,250

Table 2-11 ***Truck load No. 9—overhead-bracing load (5-ton truck)***

QUANTITY	ITEM	WEIGHT (lb) UNIT	TOTAL
13	Bag, transport	2	26
60	Bolt, bracing (in bag)	1	60
144	Bolt, chord (12 per bag)	7.5	1,080
16	Brace, sway M2	68	1,088
10	Frame, bracing	44	440
20	Support, overhead-bracing	150	3,000
	Total		5,694

Notes:

1. Two loads required for a triple-story bridge; 200' long (wo spares)
2. Overhead-bracing supports, set stock number 79.8361.500.500, are not included in bridge sets; They are class IV equipment and must be requisitioned separately; When overhead-bracing supports are not used, and triple-story bridges are braced by underslung transoms in inverted third-story panels, overhead-bracing loads are eliminated, and 13 sway braces are added to each transom load; Total transom load then weighs 6,220 pounds

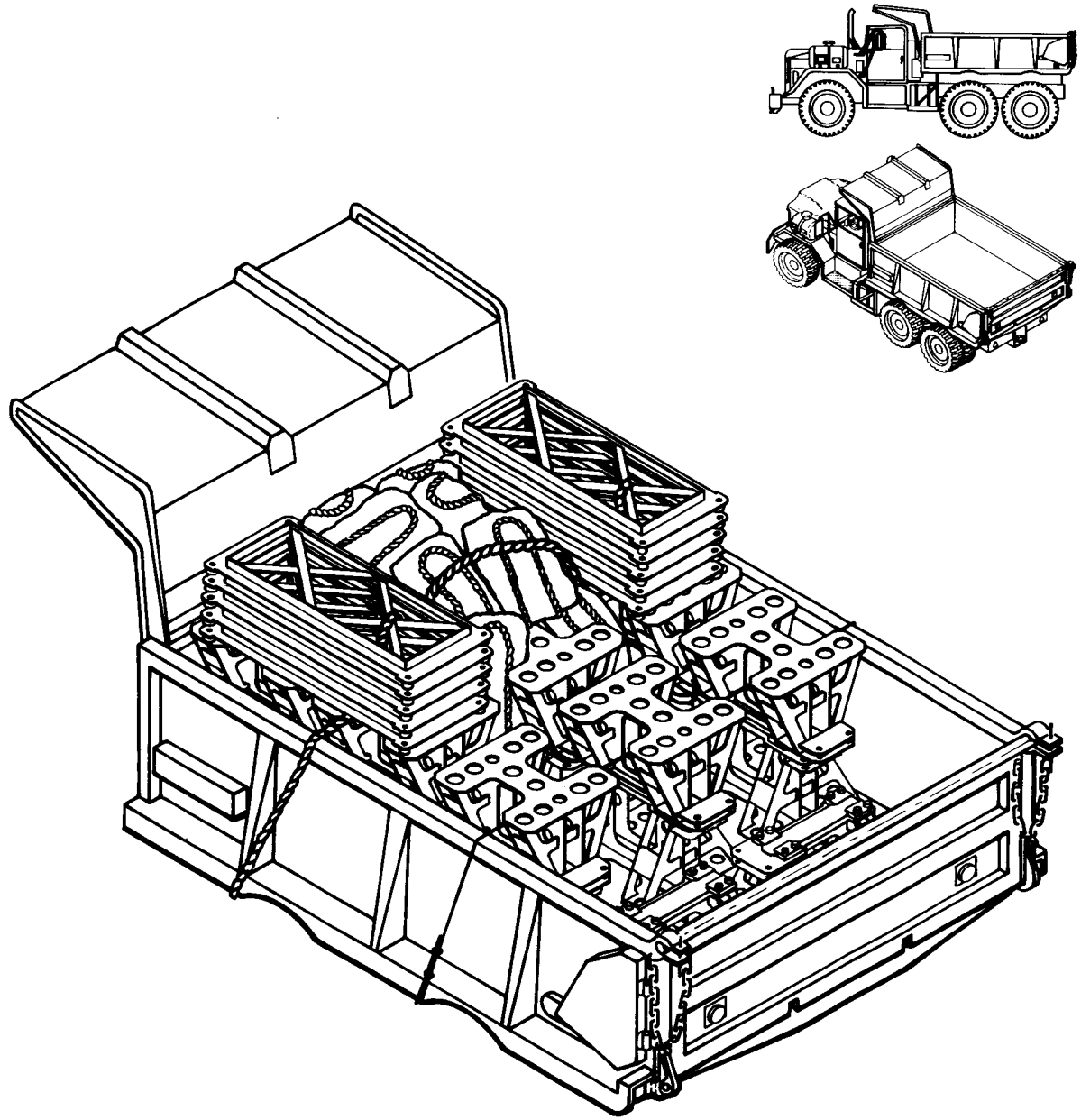


Figure 2-46 ***Truck load number 9—overhead-bracing load on 5-ton truck***

Conversion set No. 3 is carried in 2 crib-pier loads. Information on the capabilities of different standard truck loads is given in Table 2-13, and Tables A-5 and A-6 in Appendix A.

BAY LOADS

The recommended bridge load for combat operations is the bay load (Figure 2-47, page 30). Each bay load truck contains all the parts, except transoms, required for one bay (10 feet) (3.0 meters) of *double-single* Bailey bridge. This loading lends itself well to most combat engineer Bailey bridge missions. Table 2-14 (page 30) lists the parts found in the bay load. Four-ton bolster trailers carry the transoms with the bridge load mentioned earlier. The bay load is designed to be easily unloaded by crane. However, the load may also be unloaded by hand or dumped if a crane is not available. If the load is dumped, take care not to damage the chess. For a complete bridge, parts and grillage, launching nose, ramp, footwalk, spares, and overhead-bracing loads must also be included.

Table 2-12 ***Truck load No. 10—crib-pier load (5-ton truck)***

QUANTITY	ITEM	WEIGHT (lb) UNIT	TOTAL
15	Bag, transport	2	30
12	Bearing, crib	37	444
3	Bearing, junction-link	217	651
18	Bolt, bracing (in bag)	1	18
4	Bolt, chord (in bag)	7.5	30
6	Brace, sway, M2	68	408
6	Capsill, crib	251	1,506
2	Chess, junction, M2	149	298
16	Clamp, chord (in 5 bags)	11	176
16	Clamp, transom (in 2 bags)	7	112
100	Clip, retainer (in bag)	0.1	10
2	Frame, bracing	44	88
3	Link, junction	36	108
3	Link, launching-nose, MkII	28	84
60	Pin, panel (in 5 bags)	6	360
1	Pin, sway-brace, spare (in bag with chord bolts)	1	1
8	Plate, tie	3.5	28
3	Post, junction, span, female	202	606
3	Post, junction, span, male	194	582
8	Raker	22	176
	Total		5,916

Note:
Two loads transport one conversion set No. 3 which combined with standard bridge parts provides one panel crib pier

Table 2-13 ***Capabilities of standard truck loads***

NO	LOAD	LOADS REQUIRED
1	Parts and grillage	Provides site layout and erection equipment
2	Launching-nose	Provides sufficient equipment for launching nose for 80′ DS bridge, with erection tools (less one panel)
3	Panel	Provides sufficient panels for two bays DS bridge
4	Transom	Has sufficient transoms for three bays DS bridge
5	Deck	Provides sufficient stringers and chess for four bays
6	Ramp	two per bridge (20′ of ramp at each end)
7	Footwalk	one per 80′ of bridge (one walk on each side)
8	Spares	one per bridge 30′-70′ long; two per bridge 80′-150′ long; three per bridge 160′-200′ long
9	Overhead bracing	two per triple-story bridge
10	Crib-pier	See Table A-6, Appendix A

Table 2-14 ***Bay load (5-ton truck)****—(8 loads per bridge platoon; 16 loads per company)*

QUANTITY	ITEM	WEIGHT (lb) UNIT	TOTAL
12	Bolt, bracing, bridge	1	12
8	Bolt, ribband	4	36
2	Brace, sway	68	136
13	Chess, M2	65	845
8	Clamp, transom	7	56
8	Clip, retainer, steel	0.13	1.04
2	Frame, bracing, bridge	44	88
4	Panel, truss-bridge	577	2,308
8	Pin, connector, panel, long	6.1	48.8
2	Raker, side, strut	22	44
2	Ribband, guardrail	162	324
2	Stringer, button	267	534
4	Stringer, plain	260	1,040
	Total		5,473

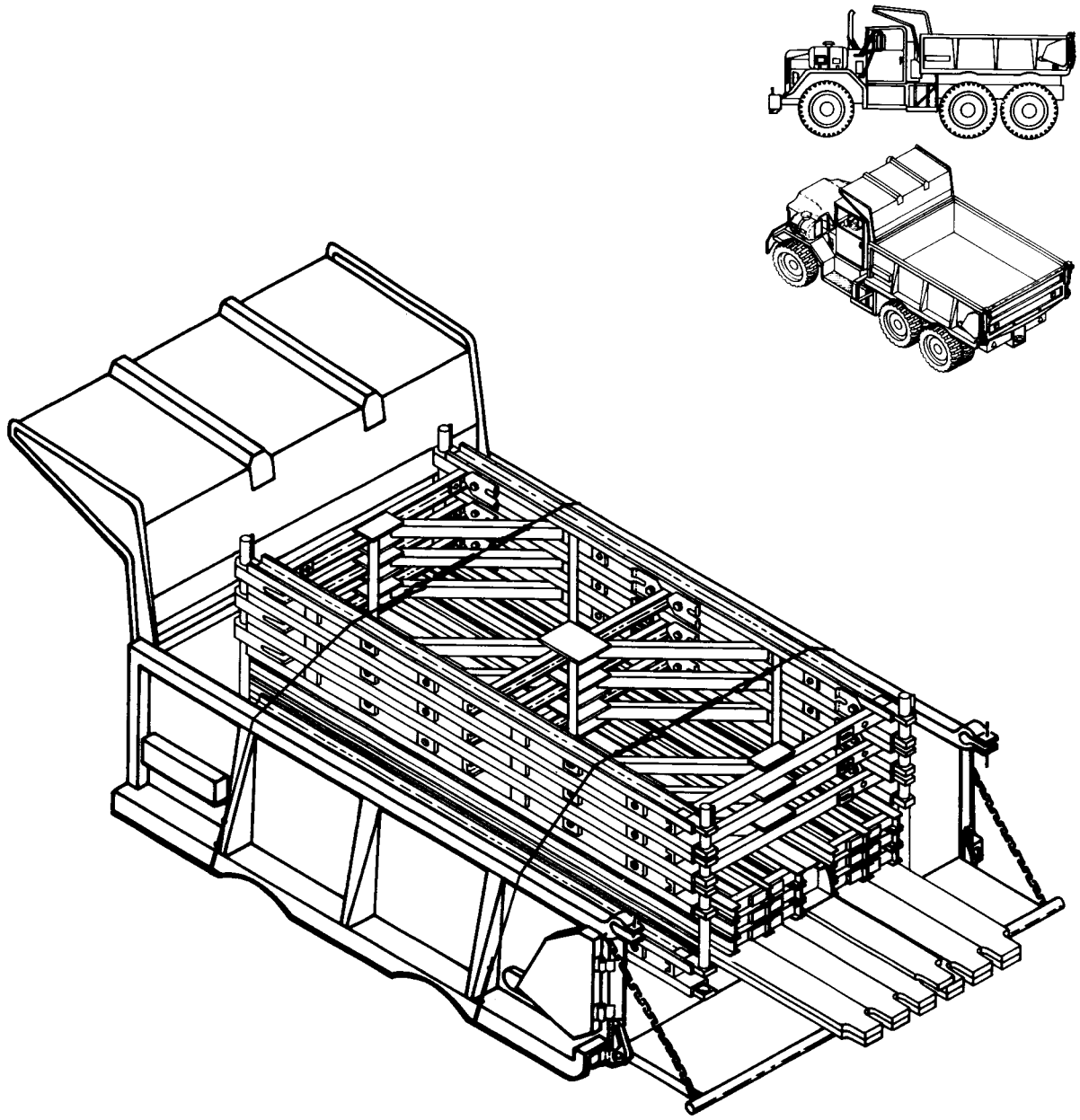


Figure 2-47 ***Bay load***

CHAPTER 3
PLANNING AND ORGANIZATION

Each bridge site must be reconnoitered to select the site most economical in use of available personnel, equipment, and time. The reconnaissance officer must be told the following before making the reconnaissance

- Where bridge is needed. The general location of the bridge is determined by tactical requirements.
- Class of bridge needed. The class of the bridge is determined by the type of vehicles it must carry.
- When bridge is needed. The time set for the bridge to become operational affects seriously planning for the mission.
- Who is to construct the bridge.

SITE RECONNAISSANCE

A thorough evaluation of information from preliminary studies may aid the reconnaissance by limiting it to a few suitable sites. Sources of preliminary information are intelligence studies and reports, interviews with local civilians, maps, aerial photographs (including stereo-pairs), and aerial reconnaissance.

SITE SELECTION

Whenever possible, make aground reconnaissance. The following site selection factors are desirable for a panel bridge:

- There should be access routes at each end of the bridge tying into the main road net. These routes should not require excessive maintenance or preparation.
- Approaches should require little preparation. These approaches should be two lane and straight for 150 feet (45.7 meters) at each end of the bridge. Their slope should not exceed 10 percent (1 in 10). Special consideration must be given to the amount of work required to prepare the approaches and piers, since this work frequently takes as much time as the bridge installation itself.
- Banks should be firm and stable and of about equal height.
- The site should be large enough for assembly of the bridge and wide enough for unloading and stacking the parts and erection tools. The approach road often provides such space.
- There should be a turnaround area large enough to allow trucks and bolster trailers to completely turn around so they can back into the site. This area is normally located about 50 feet (15.2 meters) from the bridge site.
- There should be space for an engineer equipment park—a covered and concealed area ½ to 5 kilometers behind the bridge site, in which to store vehicles and equipment when not in use at the bridge site.
- A bivouac site for construction and maintenance crews and crossing noncommissioned officer in charge should be available.

Following the reconnaissance, make out a report. The reconnaissance report describes every usable site reconnoitered, and recommends a site. The report includes

- Location of site.
- Width at gap.
- Length, truss type, and type of grillage of bridge that would be assembled at site.
- Slope of bridge.
- Condition of banks and capacity of abutments.
- Proposed location of site layout.
- Site preparation required.
- Recommended method of transporting troops and equipment to far bank.
- Sketch showing profile of centerline of the bridge, extending 100 feet (30.5 meters)

on the near shore and 50 feet (15.2 meters) on the far shore.

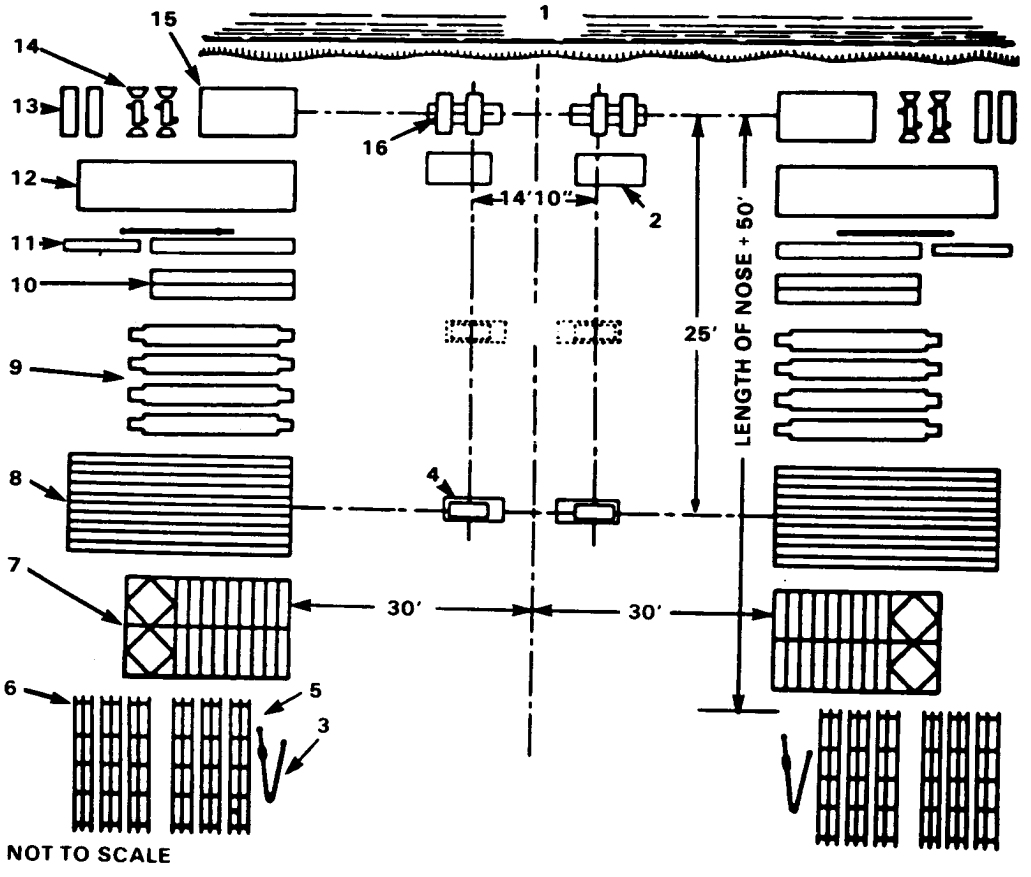
- Sketch showing layout of assembly site, and location of turnaround and engineer equipment park.
- Truck route to bridge site from engineer equipment park.

SITE LAYOUT

When the bridging is being unloaded directly from the trucks, the site must be cleared for at least as long as the width of the gap, but the width of the site need only be the width of the approach. If the bridging is to be unloaded and stacked at the site, the site must be about 150 feet (45.7 meters) wide. The stacks are arranged as shown in Figure 3-1. In restricted areas, 30 feet (9.1 meters) should be available at least on one side of the bridge to permit insertion of transoms. Otherwise, transoms must be threaded from within two bridge truss girders.

ORGANIZATION

The work force is normally organized into unloading parties and an assembly party. Each unloading party consists of one non-commissioned officer and eight soldiers. The number of unloading parties depends on the length and type of the bridge (Table 3-l). Unless an unusually large cleared area exists at the site, no more than three or four unloading parties will be able to work efficiently at one time.



1 GAP	9 CHESS
2 BASE PLATE	10 RIBBANDS AND RIBBAND BOLTS
3 SWAY BRACES	11 FOOTWALKS
4 PLAIN ROLLER ON TEMPLATE	12 BRACING BOLTS, CLAMPS, AND TOOLS
5 STRINGERS	13 END POSTS
6 RAMPS	14 JACKS AND JACK SHOES
7 PANELS	15 GRILLAGE
8 TRANSOMS	16 ROCKING ROLLERS ON TEMPLATE

Figure 3-1 Layout of bridging equipment at site

Table 3-1 ***Number of unloading parties needed***

TYPE OF CONSTRUCTION	SPAN (ft)	UNLOADING PARTIES
SS	30-60	3
	70-90	4
DS	50-80	4
	90-120	5
	70-120	5
TS	130-140	6
DD	90-150	6
	160-170	7
TD	110-120	6
	130-180	7
	190-200	8
DT	130-170	7
	180-200	8
TT	150-200	8

WARNING: The left rear soldier calls the lift commands after ensuring that all crew members are prepared to lift to prevent injury.

The various details in the assembly party are shown in Table 3-2. In most cases, this includes the panel, transom, bracing, and decking details. The duties of the panel detail are as follows:

1 It carries, places, and pins together panels in the launching nose and bridge.

2 As soon as all panels are in place, it divides into two crews. One crew crosses to far bank and begins dismantling the launching nose. The other carries necessary parts to the far bank for completion of the end of bridge and installation of the ramp.

3 It reforms as a single detail and completes dismantling of the launching nose.

4 It installs far-bank end posts.

5. It jacks down far end of bridge.

6 It installs far-bank ramp, placing chess and ribbands.

Table 3-2 ***Organization of assembly party***

DETAIL	TYPE OF CONSTRUCTION																	
	SS		DS		TS		DD		TD		DT		TT		DT		TT	
	CONSTRUCTION BY MANPOWER ONLY														USING ONE CRANE*			
	NCO	EM	NCO	EM	NCO	EM	NCO	EM	NCO	EM	NCO	EM	NCO	EM	NCO	EM	NCO	EM
Crane															0	3	0	3
Truck driver																1		1
Crane operator																1		1
Hook man																1		1
Panel	1	14	1	14	2	28	2	32	3	50	3	50	3	68	3	30	3	30
Carrying		12		12		24		28		44		44		60		24		24
Pin		2		2		4		4		6		6		8		6		6
Transom	1	9	1	10	1	10	1	10	1	10	2	28	2	28	2	20	2	20
Carrying		8		8		8		8		8		24		24		16		16
Clamp		1		2		2		2		2		4		4		4		4
Bracing	1	4	1	6	1	8	1	12	1	20	1	32	1	40	1	32	1	38
Sway brace		2		2		2		2		2		6		6		6		6
Raker		2		2		2		2		2		2		2		2		2
Bracing frame				2		2		4		4		8		8		10		8
Chord bolt								4		8		10		14		10		14
Tie plate						2				4				4				4
Overhead support												6		6		4		4
Decking	1	12	1	12	1	12	1	12	1	12	1	12	1	12	1	12	1	12
Stringer		8		8		8		8		8		8		8		8		8
Chess and ribband		4		4		4		4		4		4		4		4		4
Total	4	39	4	42	5	58	5	66	6	92	7	122	7	148	7	97	7	103

*Normally, a crane is not used for single- or double-story assembly

Duties of the transom detail areas follows:

1 It carries, places, and clamps down transoms.

2 It removes plain rollers on near bank.

3 It installs end posts on near bank.

4 It helps decking detail in jacking down near end of bridge.

5 It installs near-bank ramp and helps decking detail in placing chess and ribbands on it.

Duties of the bracing detail are to obtain, install, and adjust the following parts:

- Sway braces.
- Rakers.
- Bracing frames, on all but *single-single* bridges.
- Chord bolts, on double- and triple-story bridges only.
- Tie plates, on triple-truss bridges only.
- Overhead-bracing supports, on triple-story bridges only.

Duties of the decking detail areas follows:

1 It assists panel detail in starting assembly of the launching nose.

2 It lays stringers, chess, and ribbands on bridge.

3 It jacks down near end of bridge.

4 It lays chess and ribbands on near-bank ramp.

ASSEMBLY TIME

Time for assembly and installation of a normal bridge is given in Table 3-3. Table 3-3 shows estimated times for daylight assembly and launching of various lengths of different types of bridges when built by manpower alone and when using one crane. Times do not include preparation of site and layout of rollers. These times assume there is a favorable assembly site, trained personnel are available, equipment is stacked at the site, and footwalks are omitted. Use of untrained troops, poor weather, various terrain conditions, and enemy activity will lengthen assembly time by 30 percent. Added time must also be allowed for placing wear treads. Add ½ to 4 or more hours for preparation of site and layout and placing of rollers (depending upon the amount of work required to level site, install grillages, and crib up rollers). Add ½ hour for unloading from trucks if separate unloading parties are available. If not available, add 1 to 2½ hours according to type of bridge. For blackout conditions, increase daylight times by 50 percent. For mission-oriented protection posture (MOPP) conditions, increase final construction (all other conditions considered) by 50 percent.

Table 3-3 ***Estimated time for assembly***

SPAN (ft)	TYPE OF CONSTRUCTION								
	SS	DS	TS	DD	TD	DT	TT	DT	TT
	TIME (hours)								
	CONSTRUCTION BY MANPOWER ONLY							USING ONE CRANE	
40	1½								
60	1¾	2							
80	2	2½	3						
100	2¼	3	3½	4¼					
120		3½	4	5	6¾				
140		3¾	4½	5¾	7½	11¾		10½	
160			5	6¼	8½	13¼	19	11¾	16¼
180				7	9½	14¾	21¼	13¾	18¼
200						16¼	24	14½	20½

INSTALLATION PROCEDURE

Installation procedure begins with site preparation (clearing mines, removing obstacles, constructing a turnaround for trucks). Installation then includes the following steps: roller layout (including baseplates), unloading of bridge equipment, bridge assembly and launching, bridge jackdown and ramp assembly, and installation of wear treads and footwalks.

MOVEMENT CONTROL

Proper planning for the movement of bridge trucks is important in providing, without confusion, the bridge equipment when it is needed. If the equipment is to be stacked at the site, time the transportation to arrive as soon as the stacking site is ready.

CHAPTER 4
FIELD DESIGN AND CLASSIFICATION

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LAUNCHING NOSE 49
ROLLERS AND JACKS 51
RAMP REQUIREMENTS 52
EXAMPLE FIELD DESIGN PROBLEM 54
BRIDGE CLASSIFICATION 56

The Bailey bridge may be adapted to fit almost any gap. The field design procedure first determines the initial length of bridge required, and then the truss type needed to carry the required class of traffic is determined. Finally, the required grillage is determined. However, the grillage type may cause a change to the initially determined bridge length. If so, the truss type will have to be rechecked, as well as the grillage type, for the new bridge length. To complete the field design, the number of rollers and jacks needed must also be determined.

LENGTH, TRUSS TYPE, AND GRILLAGE TYPE

DETERMINING INITIAL BRIDGE LENGTH

The initial bridge length is determined by adding the width of the gap, the safety setbacks, and the roller clearances.

Gap

The measurement of the gap depends on the condition of the abutments (Figure 4-1). These are usually classified as prepared, unprepared, or a combination of the two.

Prepared abutments are abutments which can hold the bridge load close to the face without failing. Examples of prepared abutments are mass concrete, headwall with piles, and headwall with footers and deadman. Technical Manual (TM) 5-312 gives more detailed information on prepared abutments. The gap is measured between the faces of two prepared abutments.

An unprepared abutment is one which would probably fail if the bridge load were applied close to its edge. Examples of unprepared abutments are natural slopes, demolished abutments, or abutments with headwalls that are not strong enough to hold the load. The gap is measured from the toe of the slope of one unprepared abutment to the toe of the slope of the other.

If both prepared and unprepared abutments exist on one bridge site, the gap is measured from the face of the prepared abutment to the toe of the slope of the unprepared abutment.

Caution: **Care must be taken when completing the design process or the bridge will fail. Abutment types and location of the toe of the slope for unprepared abutments should be done carefully. Incorrectly classifying abutment types or locating the toe of the slope is the most common and dangerous design mistake. When in doubt, always classify the abutment as unprepared. If an abutment is par-**

tially prepared, determine the toe of the slope at the base of the prepared face. If the face is in poor condition, determine the "real" toe of slope. Be sure to remember to measure bank height at the toe of the slope.

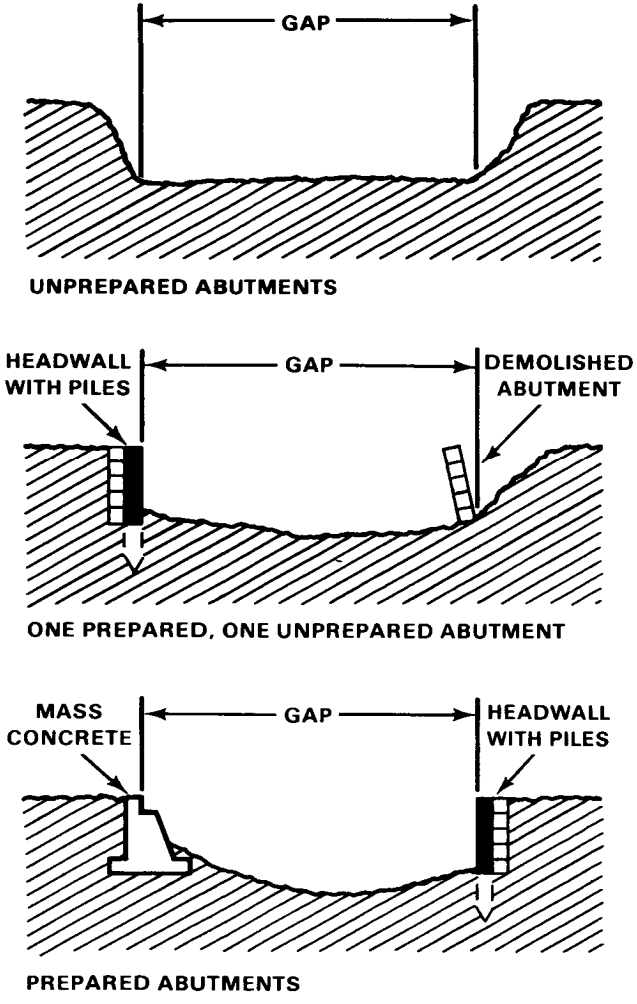


Figure 4-1 ***Measuring the gap—prepared and unprepared abutments***

Safety setback

Safety setback is the minimum distance that each rocking roller must be behind the bank of the gap. This distance depends on the condition of the abutments on each bank (Figure 4-2). If the bridge site has prepared abutments, the rocking rollers are set back a minimum of 3 feet 6 inches (1.1 meters) from the edge of the abutment.

When unprepared abutments exist, the safety setback must be calculated. If the rollers are placed too close to the edge of the gap, the soil may fail during launching. Therefore, place the rocking rollers at a location behind the toe of slope of the soil. For field design, the toe of slope is where the bank's surface is 45 degrees (an average value) from the horizontal direction. This would mean that the rocking roller should be set back a distance equal to the height of the bank. However, an additional safety factor of 50 percent is added. Therefore, the safety setback is 1.5 times the bank height. The bank height is measured from the toe of the slope to the ground level at the abutment. The safety setback is measured back from the toe of the slope.

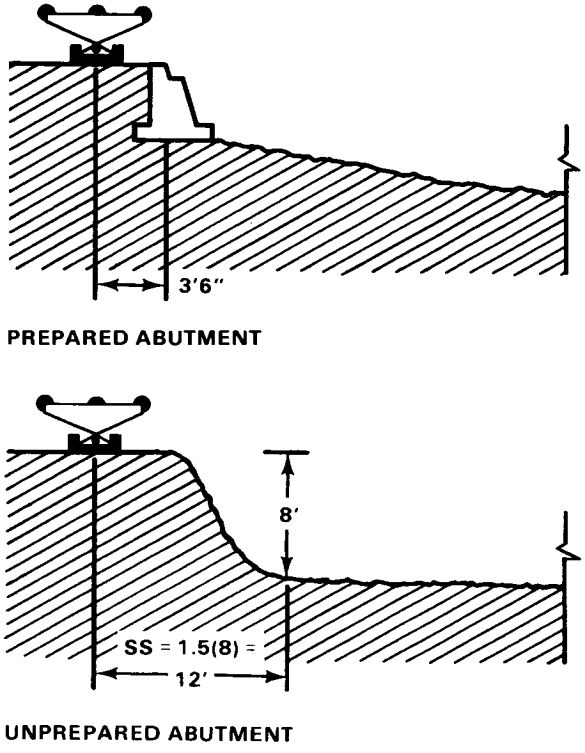


Figure 4-2 ***Safety setback—prepared and unprepared abutments***

EXAMPLE:
Given:
Unprepared abutment
Bank height 8 feet (2.44 meters)

Required:
Determine the safety setback (SS)

Solution:
Safety setback = 1.5x bank height
or 1.5 x 8 feet = 12 feet (3.66 meters)

Roller clearance

Roller clearance is the distance from the center of the rocking roller to the center of the bearing on which the bridge end posts will rest (Figure 4-3, page 38). The normal roller clearance, about 2 feet 6 inches (0.76 meters), is always used when determining the initial bridge length. The actual roller clearance will be determined by the type of grillage used.

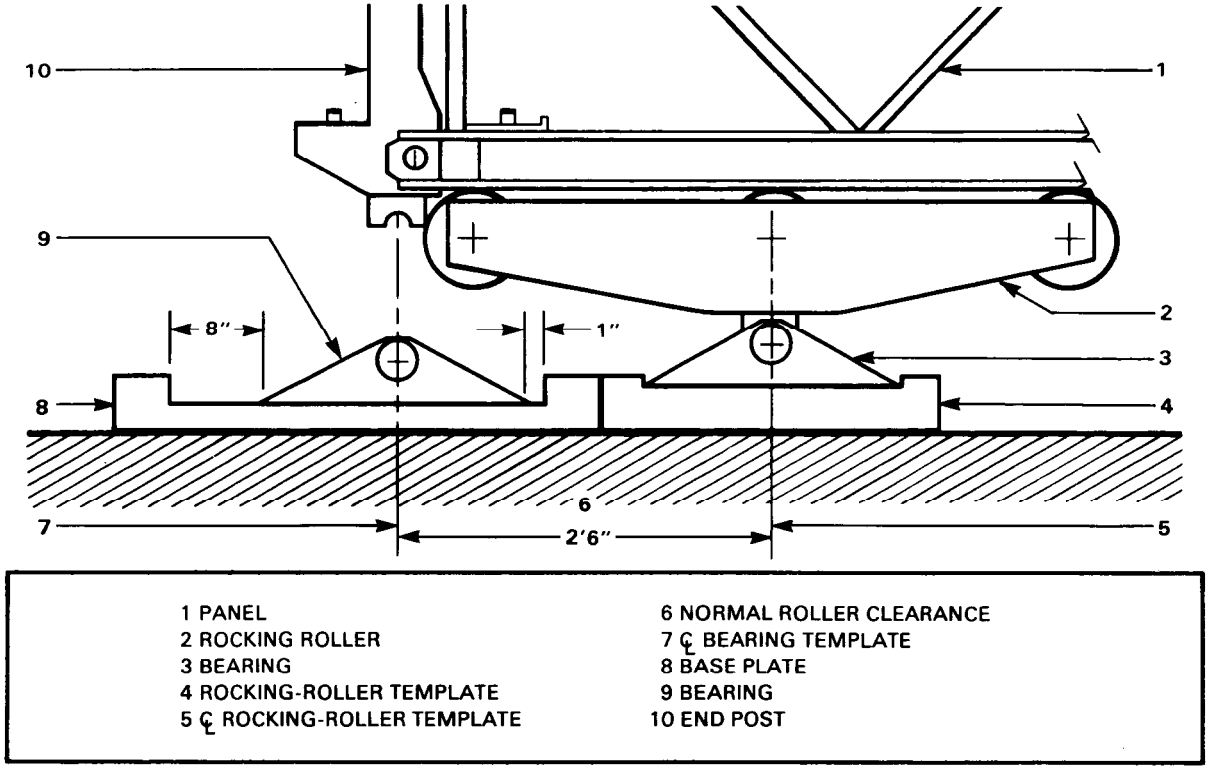


Figure 4-3 ***Rocking rollers and base plate at the end of bridge***

An example of computing bridge length with both abutments prepared (Figure 4-4) is as follows:

Given:
Gap is 56 feet (17.07 meters) (abutment to abutment)

Required:
Determine initial bridge length

Solution:
Initial bridge length (bL_i) = gap + safety setbacks + roller clearances

bL_i = 56 feet+ (3.5 feet+ 3.5 feet) + (2.5 feet + 2.5 feet)
bL_i = 68 feet (20.73 meters)

Round up to the next 10-foot (3.05 meters) length to equal 70 feet (21.37 meters)

An example of computing bridge length with both abutments unprepared (Figure 4-4) is as follows:

Given:
Gap measurement (toe to toe)—
57 feet (17.37 meters)

Bank height—Near shore: 9 feet (2.74 meters)
Far shore: 12 feet (3.66 meters)

Required:
Determine initial bridge length

Solution:
bL_i = gap + safety setbacks + roller clearances

bL_i = 57 feet + [1.5(9 feet) + 1.5 (12 feet)] + (2.5 feet+ 2.5 feet)
= 93.5 feet (28.5 meters)
bL_i = 95.5 (29.11 meters)

Round up to the next 10 feet (3.05 meters) to equal 100 feet (30.48 meters)

An example of computing bridge length with one prepared and one unprepared abutment (Figure 4-4) is as follows:

Given:
Gap measurement (toe to toe)—
53 feet (16.15 meters)

Bank height unprepared shore—
10 feet (3.05 meters)

Required:
Determine initial bridge length

Solution:
bL_i = gap + safety setbacks + roller clearances

bL_i = 53 feet+ [3.5 feet+ 1.5(10 feet)] + (2.5 feet + 2.5 feet)
bL_i = 76.5 feet (23.32 meters)

Round up to 80 feet (24.38 meters)

TRUSS TYPE

The required truss type for a given length of Bailey bridge to carry a specified class of traffic is found in Table A-7 in Appendix A. The actual class of the bridge maybe greater than required, but not less.

Note: The truss type required for a normal crossing is always used unless otherwise directed by the field commander.

EXAMPLE:
Given:
Bridge length — 80 feet (25.97 meters)

Required class — 60 wheel/60 track

Required:
Determine the truss type required

Solution:
From Table A-6 in Appendix A
Truss type: *triple-single*
Design class — 85 wheel/80 track

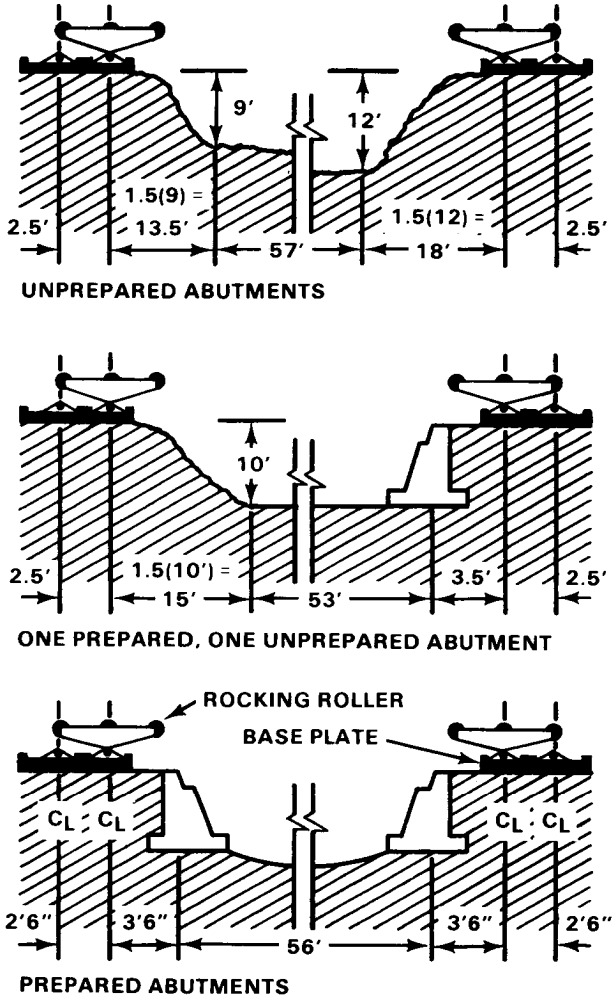


Figure 4-4 ***Profile of bridge site—prepared and unprepared abutments***

TYPE OF GRILLAGE NEEDED

The end posts at each end of the bridge are supported by bearings set on base plates. During launching, the entire weight of the bridge is carried by the near-bank rocking rollers, which rest on rocking-roller template. Grillages are used to spread the load over a larger area (Figures 4-5 through 4-11, pages 40 through 44) when the soil-bearing capacity is exceeded. Grillages also serve as cribbing to raise base plates or rollers to the desired level.

Description

Grillages are made of squared timbers laid under the base plate or roller template. These must be carefully leveled transversely; grillages on each side of the bridge must be level with each other so that all trusses will rest on bearing plates. If bearing plates are not level transversely, only one truss will carry the load at first, until deflection under load brings the other trusses to bear. The first truss to bear will then be overstressed before the last truss can be fully utilized. This can result in failure under less than the rated load of the bridge.

Timbers for use as standard grillages are supplied in panel bridge sets. The panel bridge set supplies 144 each 6-by 6-inch (15.2 by 15.2 centimeters) timbers 4½ feet (1.4 meters) long, and 48 each 3- by 6-inch (7.6 by 15.2 centimeters) timbers 4½ feet (1.4 meters) long for grillage. Standard grillages using these timbers and panel bridge parts are illustrated in Figures 4-5 through 4-8.

On soft soils, some of the heavier bridges will require larger grillages than can be built from the timbers supplied in the set. For these bridges, grillages built from 8- by 8-inch (20.3 by 20.3 centimeters) timbers are shown in Figures 4-9 through 4-11.

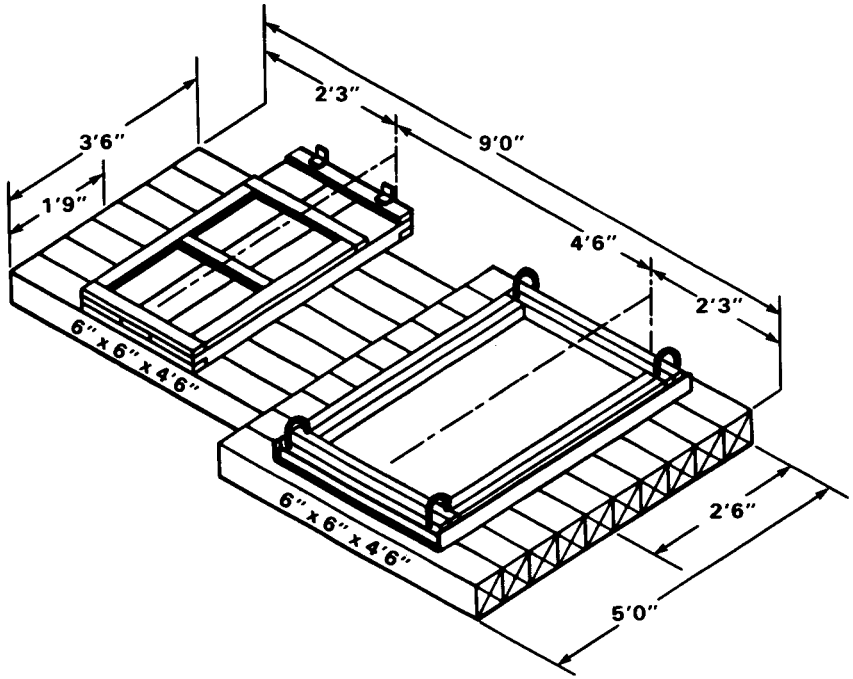
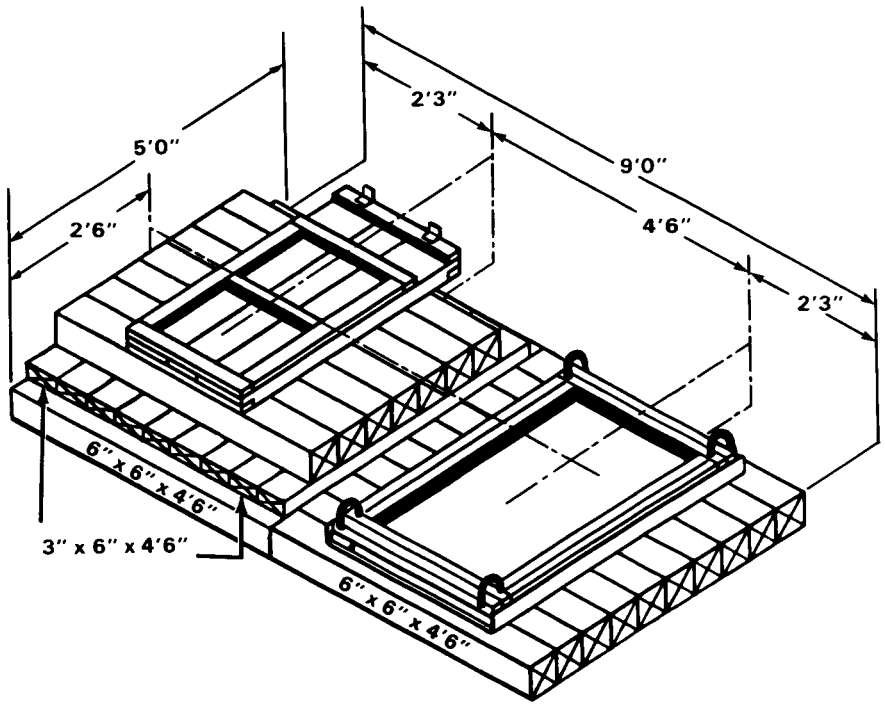


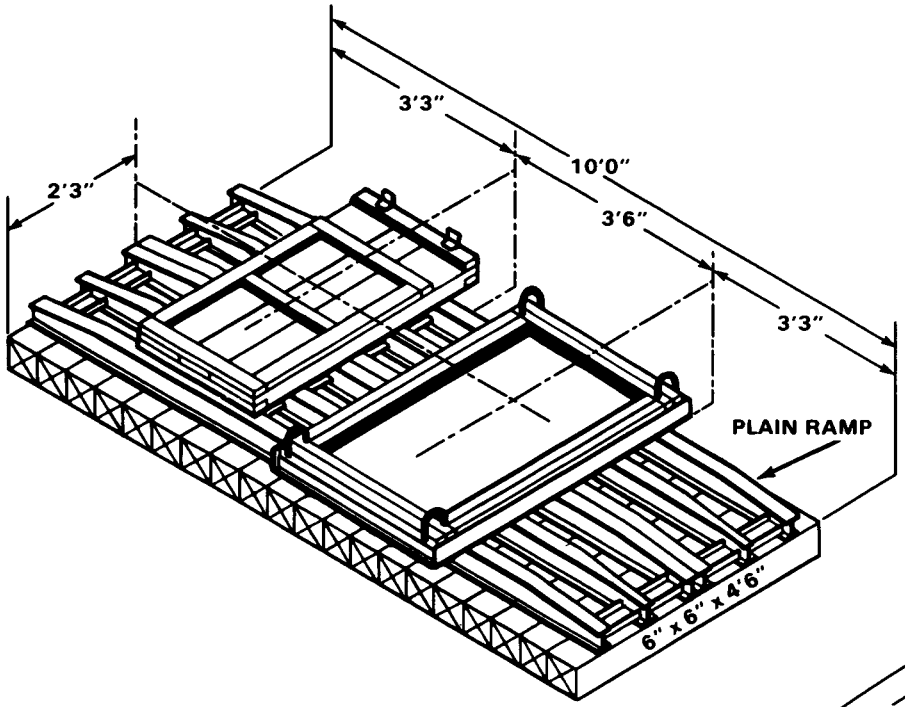
Figure 4-5 ***Type 1 grillage***

MATERIAL
17 PCS 6" x 6" x 4'6"



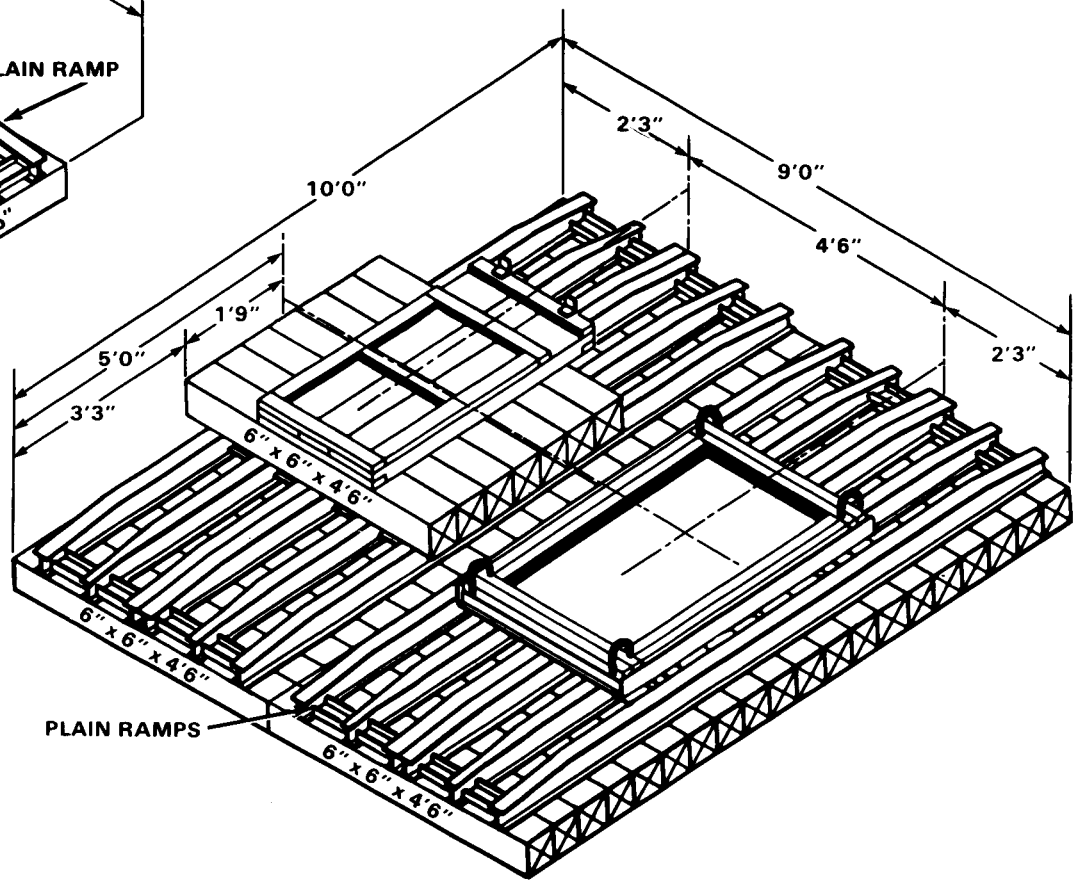
MATERIAL
27 PCS 6" x 6" x 4'6"
9 PCS 3" x 6" x 4'6"

Figure 4-6 ***Type 2 grillage***



MATERIAL
20 PCS 6" x 6" x 4'6"
2 PLAIN RAMPS

Figure 4-7 ***Type 3 grillage***



MATERIAL
47 PCS 6" x 6" x 4'6"
4 PLAIN RAMPS

Figure 4-8 ***Type 4 grillage***

MATERIAL
12 PCS 8" x 8" x 12'0"
5 PCS 8" x 8" x 8'0"
3 PCS 8" x 8" x 6'0"

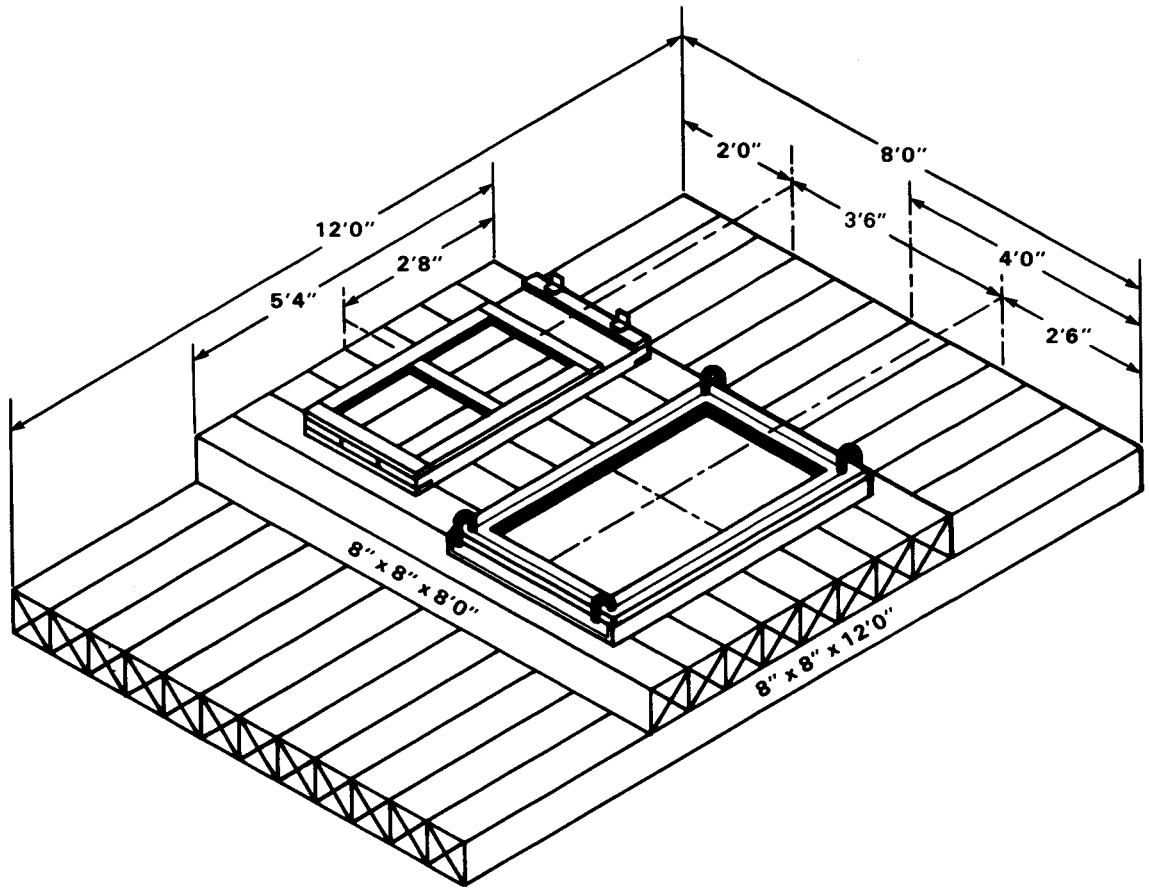


Figure 4-9 ***Type 5 grillage***

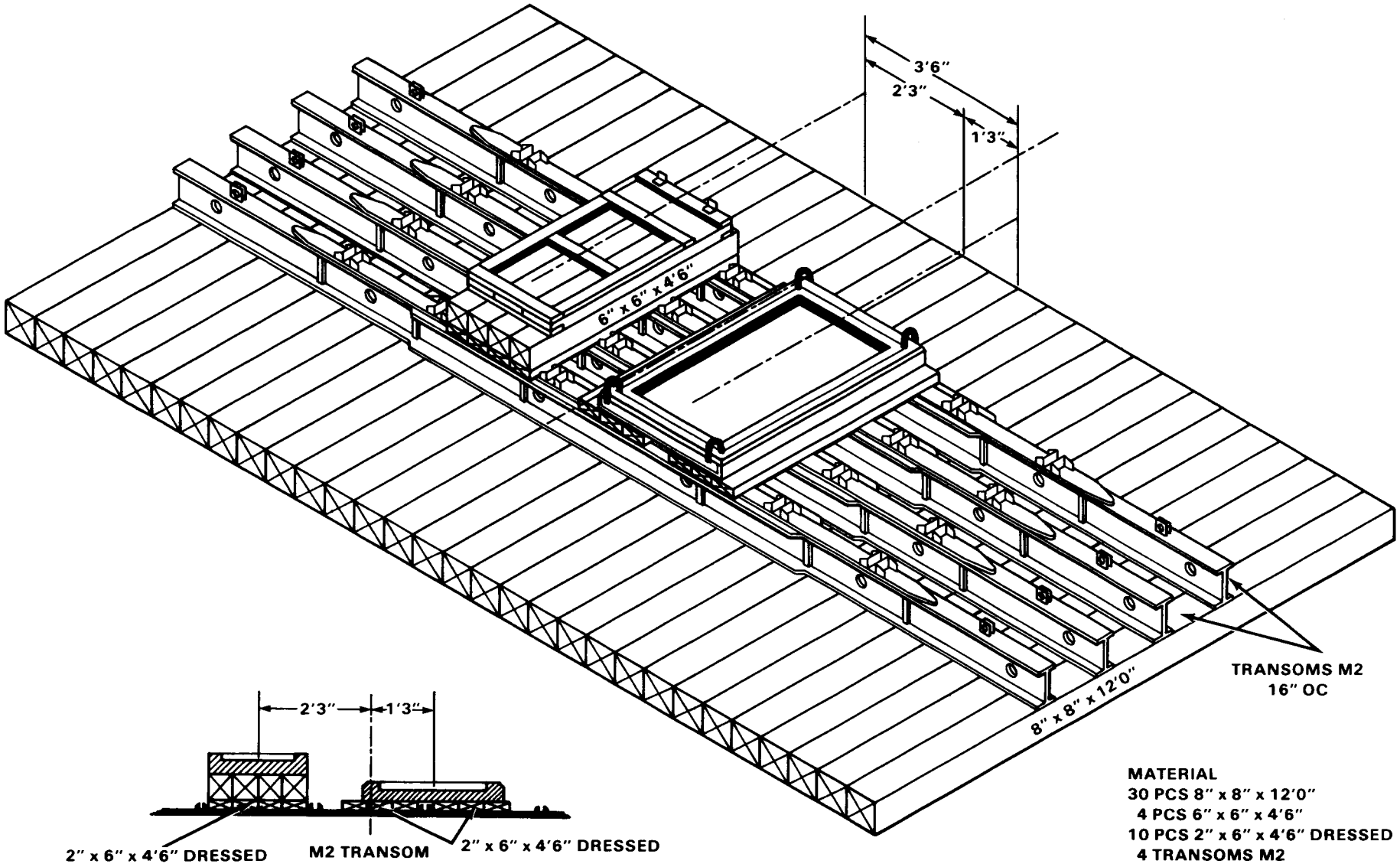


Figure 4-10 ***Type 6 grillage***

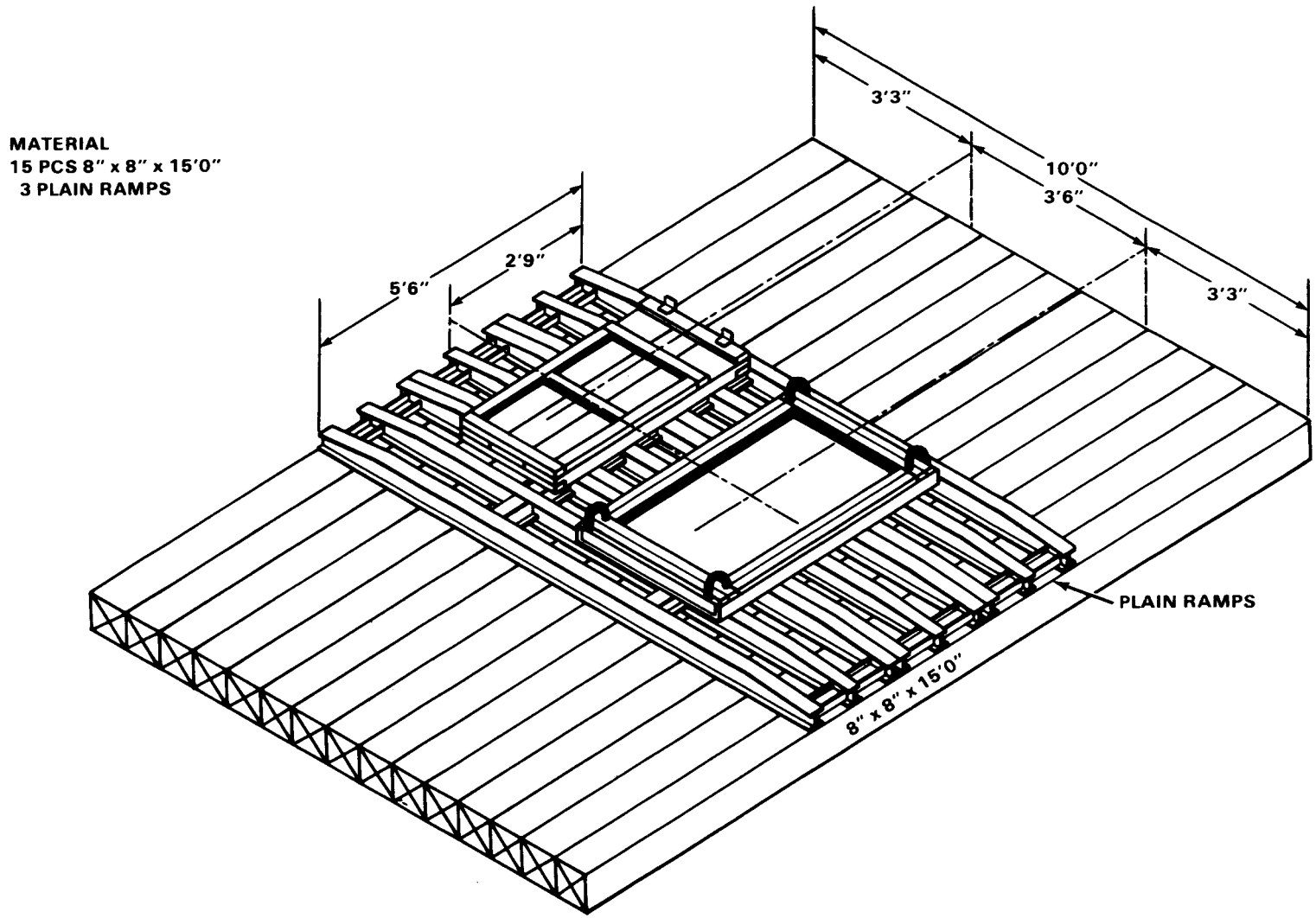


Figure 4-11 ***Type 7 grillage***

Nonstandard grillages, made of other size timbers, can be used if each layer is at least as thick and wide as the corresponding standard grillage. Squared timbers should be used, since rough cut timbers often result in uneven, wobbly cribs.

Selection of grillage

The selection of grillage is determined by the bridge length, the truss type, and the soil-bearing capacity. Table 4-1 give the safe bearing pressure in tons per square foot (t/sf) on various soils. A careful evaluation of the soil character is essential to prevent grillage failures. Note that in sandy or gravelly soils, the bearing power of the soil is increased when the grillage is dug in so that it bears on the soil 1½ feet (.46 meter) or more below the surrounding surface.

Note: If soil-bearing capacity value from Table 4-1 is not listed on Table 4-4, the number must be rounded down to obtain the proper grillage type.

Table 4-2 (page 46) gives the load on grillage at one comer of the bridge. Note that in some bridges the rocking-roller reaction is greater than the base-plate reaction. Table 4-3 (page 47) gives the load capacities for the grillage in varying soils. The type of grillage required may be found by determining the bridge reaction from Table 4-2 and then selecting a grillage type from Table 4-3 which has the required capacity for the proper soil type. The

Table 4-1 Safe bearing capacity for various soils

SOIL DESCRIPTION	BEARING VALUES (tons per sq ft)
Hardpan overlying rock	12
Very compact sandy gravel	10
Loose gravel and sandy gravel, compact sand and gravelly sand; very compact sand, inorganic silt soils	6
Hard dry consolidated clay	5
Loose coarse-to-medium sand; medium-compact fine sand	4
Compact sand clay	3
Loose fine sand; medium-compact sand, inorganic silt soils	2
Firm or stiff clay	1.5
Loose saturated-sand clay soils; medium-soft clay	1

grillage types for various soils and bridge types are also given in Table 4-4 (page 48).

EXAMPLE:
Given:
Bridge length—80 feet (25.97 meters)

Truss type—*triple-single*

Soil type—loose fine sand

Required:
Determine the grillage type required

Field solution:
From Table 4-1, soil-bearing capacity is 2 t/sf

From Table 4-4, grillage type required is type 4

Detailed analysis:
From Table 4-2, corner reactions are 59 tons (54 metric tons)—base plate, 19.0 tons (17.2 metric tons)—rocking rollers

From Table 4-3, type 4 grillage provides the necessary capacities. Type 4 provides 71 tons (64 metric tons)—base plate, 57 tons (52 metric tons)—rocking roller.

It is unlikely that the near and far banks would have different soil-bearing capacities but, if so, grillage is determined separately for each bank. The maximum allowable slope for a Bailey bridge is 1 to 30. If bank heights differ enough to cause a greater slope, the low end may be cribbed up to decrease the slope. The cribbing must have at least the same bearing area as the required grillage. If cribbing is impractical, the high end may be excavated to reduce the slope. Figures 4-5 through 4-11 show the dimensions and necessary materials for the grillage types.

Note: Types 5, 6, and 7 are made from materials not issued with the bridge set.

DETERMINING FINAL BRIDGE LENGTH

The grillage type required may increase the roller clearance. This may affect the required bridge length. If so, the truss and grillage type must be rechecked for the new bridge length. The required roller clearances for

each type of grillage are shown in Figures 4-5 through 4-11. The roller clearance and total grillage height are given in Table 4-5 (page 49).

EXAMPLE:
Given:
Initial bridge length—76.5 or 80 feet (23.9 or 24.4 meters)

Required class—50 wheel/55 track

Initial truss type—*double-single*

Soil-bearing capacity—2 t/sf

Required:
Determine the final bridge length, truss, and grillage type

Solution:
Use the following steps:

1 Grillage from Table 4-4 —type 1 required

2 Roller clearance from Table 4-5 or Figure 4-5—4 feet 6 inches (1.4 meters)

3 Initial roller clearance was 2 feet 6 inches (.76 meter); therefore, 2 more feet (.6 meter) must be added to each end of bridge:

New bridge length
= 76.5 feet + 2 feet + 2 feet
= 82.5 or 90 feet (27.43 meters)

*Table 4-2 **Maximum base-plate and rocking-roller reactions, on grillage at one corner of bridge***

SS	Span, in feet	30	40	50	60	70	80	90	100		
	Safe capacity	40	32	28	26	22	18	13	10		
	Caution capacity	55	45	38	35	31	23	19	13		
	Base-plate reaction [1]	31	26	24	21.8	21	18	17	15		
	Rocking-roller reaction [2]	5.7	7.4	8.9	10.7	12.7	13.9	15.9	14.4		
DS	Span, in feet	50	60	70	80	90	100	110	120	130	140
	Safe capacity	80	67	64	51	44	31	23	18	13	10
	Caution capacity	100	84	80	64	55	40	34	23	19	13
	Base-plate reaction [1]	56	48	45	39	35	30	27	23	22	20
	Rocking-roller reaction [2]	10.5	12.8	14.5	16.8	18.8	20.5	22.8	24.9	26.8	23.9
TS	Span, in feet	80	90	100	110	120	130	140	150	160	
	Safe capacity	80	62	52	40	34	23	18	13	10	
	Caution capacity	100	78	65	50	43	32	23	19	13	
	Base-plate reaction [1]	59	50	43.5	38	34.5	31	27	26	25	
	Rocking-roller reaction [2]	19.0	21.5	23.5	26.0	28.0	30.5	33.0	30.5	29.8	
DD	Span, in feet	100	110	120	130	140	150	160	170	180	
	Safe capacity	75	64	50	40	31	23	19	13	10	
	Caution capacity	94	80	63	51	44	32	29	19	13	
	Base-plate reaction [1]	60	53	47	42	39	35	35	32	30	
	Rocking-roller reaction [2]	26.8	29.8	32.0	34.8	38.3	41.0	38.0	40.8	38.3	
TD	Span, in feet	110	120	130	140	150	160	170	180	190	
	Safe capacity	80	70	57	48	40	31	23	18	12	
	Caution capacity	100	88	75	61	50	43	31	23	16	
	Base-plate reaction [1]	68	62	57	53	49	48	44	42	40	
	Rocking-roller reaction [2]	35.8	39.3	43.3	46.8	50.3	51.0	49.3	47.0	46.0	
DT	Span, in feet	130	140	150	160	170	180	190	200	210	
	Safe capacity	80	67	65	56	50	40	31	23	18	
	Caution capacity	100	87	81	70	63	50	44	31	23	
	Base-plate reaction [1]	73	67	55	64	63	60	58	54	51	
	Rocking-roller reaction [2]	47.5	50.8	54.8	59.0	59.8	59.5	56.8	55.5	56.3	
TT	Span, in feet	170	180	190	200	210					
	Safe capacity	70	57	50	40	29					
	Caution capacity	88	75	64	50	36					
	Base-plate reaction [1]	85	82	78	75	69					
	Rocking-roller reaction [2]	60	60	60	60	60					

[1]Includes weight of footwalks, ramps, bearings, and base plate; Live load assumed to be caution load on centerline of bridge
[2]Includes weight of rocking rollers, bearings and template

Table 4-3 ***Capacities, in tons, of grillages shown in Figures 4-5—4-11***

TYPE OF GRILLAGE	SAFE BEARING PRESSURE OF SOIL (tons per sq ft) 0.5		1.0		2.0		2.5		3.5			MATERIAL REQUIRED
	MAXIMUM SAFE AND ALLOWABLE LOADS ON BASE PLATE (BP) AND ROCKING-ROLLER TEMPLATE (RRT)											
	BP	RRT	BP	RRT	BP	RRT	BP	RRT	BP	RRT		
	7	3	13	6	27	12	34	15	47	21		NO GRILLAGE REQUIRED
1	11	8	22	16	45	31	56	39	79	45	SUPPLIED IN PANEL BRIDGE SET	7 pcs 6" x 6" x 4'6"
2	11	10	22	20	45	40	56	51	79	60	SUPPLIED IN PANEL BRIDGE SET	7 pcs 6" x 6" x 4'6"; 9 pcs 3" x 6" x 4'6"
3	13	9	26	19	51	37	61	46	61	60	SUPPLIED IN PANEL BRIDGE SET	ramps; 20 pcs 6" x 6" x 4'6"
4	22	22	45	45	71	57	71	57	71	57	SUPPLIED IN PANEL BRIDGE SET	ramps; 47 pcs 6" x 6" x 4'6"
5	30	17	59	34	75	34	75	34	75	34	NOT SUPPLIED IN PANEL BRIDGE SET	pcs 8" x 8" x 6'0"; 5 pcs 8" x 8" x 8'0"; 12 pcs 8" x 8" x 12'0"
6	87	60	90	60	90	60	90	60	90	60	NOT SUPPLIED IN PANEL BRIDGE SET	transoms; 10 pcs 2" x 6" x 4'6"; 4 pcs 6" x 6" x 4'6"; 30 pcs 8" x 8" x 12'0"
7	43	31	86	60	99	60	99	60	99	60	NOT SUPPLIED IN PANEL BRIDGE SET	ramps; 15 pcs 8" x 8" x 15'0"

4 Recheck truss type, Table A-6 in Appendix A—90 feet
—*triple-single* required

5 Recheck grillage, Table 4-4
—type 3 required

6 Recheck roller clearance, Table 4-5, Figure 4-7—3 feet 6 inches (1.07 meters)

This will not increase the bridge length

7 Final design—
90 feet (27.43 meters)
triple-single,
type 3 grillage

Table 4-4 ***Types of grillage needed***

TYPE OF CONSTRUCTION		SPAN (ft) 30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
SS	0.5	6,7	5,6,7	5,6,7	4	4	4	4	4											
	1.0	4	3	3	1	1	1	1	1											
	2.0	1	None	None	None	None	1	1	1											
	2.5	None	None	None	None	None	None	None	None											
	3.5	None	None	None	None	None	None	None	None											
DS	0.5			6	6	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7							
	1.0			6,7	5,6,7	4	4	4	4	4	4	4	4							
	2.0			4	3	1	1	1	1	1	1	1	1							
	2.5			1	1	1	1	1	1	1	1	1	1							
	3.5			1	None	None	None	None	None	1	1	1	1							
TS	0.5						6	6	6,7	6,7	6,7	6,7	6	6,7	6,7					
	1.0						6,7	5,6,7	4	4	4	4	4	4	4					
	2.0						4	3	1	1	1	1	2	1	1					
	2.5						3	1	1	1	1	1	1	1	1					
	3.5						1	1	1	1	1	1	1	1	1					
DD	0.5								6	6	6	6	6	6	6	6	6			
	1.0								6,7	5,6,7	5,6,7	4	4,6,7	4,6,7	4,6,7	4,6,7	4,6,7			
	2.0								4	4	3	2	2	4,6,7	2	4,6,7	2			
	2.5								3	1	1	1	1	2	1	2	1			
	3.5								1	1	1	1	1	1	1	1	1			
TD	0.5									6	6	6	6	6	6	6	6	6		
	1.0									6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7		
	2.0									4,6,7	4,6,7	4,6	4,6,7	4,6,7	4,6,7	4,6,7	4,6,7	4,6,7		
	2.5									4,6,7	3	2	2	2	2	2	2	2		
	3.5									1	1	1	2	2	2	2	2	2		
DT	0.5											6		6	6	6	6	6	6	6
	1.0											6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7	6,7
	2.0											6,7	4,6,7	4,6,7	6,7	6,7	6,7	4,6,7	4,6,7	4,6,7
	2.5											6,7	4,6,7	4,6,7	6,7	6,7	6,7	4,6,7	4,6,7	4,6,7
	3.5											2	2	2	2	2	2	2	2	2
TT	0.5															6	6	6	6	6
	1.0															6,7	6,7	6,7	6,7	6,7
	2.0															6,7	6,7	6,7	6,7	4,6,7
	2.5															6,7	6,7	6,7	6,7	4,6,7
	3.5															6,7	6,7	2	2	2

Table 4-5 ***Roller clearance and grillage height***

GRILLAGE TYPE	OVERALL HEIGHT (in)	BASE-PLATE HEIGHT (in)	ROLLER CLEARANCE
1	6	6	4'6"
2	15	6	4'6"
3	11	11	3'6"
4	17	11	4'6"
5	16	16	3'6"
6	26	20	3'6"
7	13	13	3'6"

LAUNCHING NOSE

COMPOSITION

The launching nose (Figure 4-12, page 50) is a skeleton framework consisting of panels, transoms, rakers, sway braces, and, when necessary, launching-nose links. It does not have stringers or decking. One transom with transom clamps and rakers is used behind the leading upright of each panel. Sway bracing is used in all but the first bay at the front of the launching nose. Footwalks are not assembled on the nose.

USE OF LAUNCHING NOSE

The panel bridge is normally launched by cantilevering the launching nose over the gap. The weight of the bridge acts as the counterweight. When the launching nose reaches the far shore, it rests on the rocking rollers and supports the bridge as it is pushed across the gap. The composition of the nose depends on the length of the bridge and the type of assembly. The composition of the launching nose for the various combinations of span and bridge assembly is shown in Figure 4-12 and given in Chapter 6, Tables 6-1 through 6-3; Chapter 7, Tables 7-1, 7-2; and Chapter 8, Tables 8-1, 8-2. These tables must be followed exactly.

USE OF LAUNCHING-NOSE LINKS

The launching nose tends to sag as it is cantilevered over the gap. The approximate sag at the end of the nose just before it reaches the far bank is shown in the above mentioned tables. To overcome this sag, launching-nose links are used. Using one launching-nose link in each truss increases the length of the bottom chords of the nose by 7½ inches (19.0 centimeters); thus, the end of the launching nose is raised by 13½ inches (34.3 centimeters) for each bay ahead of the links. Because links must not be inserted with more than four bays of the launching nose ahead of them, the maximum amount of lift that can be obtained from one pair of links is about 54 inches (137 centimeters). If a greater amount of lift is required, an added pair of links can be used in one of the joints between the original pair and the end of the nose. Its position depends on how much lift is required. Figure 4-12 shows the vertical lifts that can be obtained using one or more pairs of links. The maximum lift obtainable using launching-nose links is 94½ inches (239.8 centimeters). When calculating the position of the links, add 6 inches (15.2 centimeters) to sag values shown for safety.

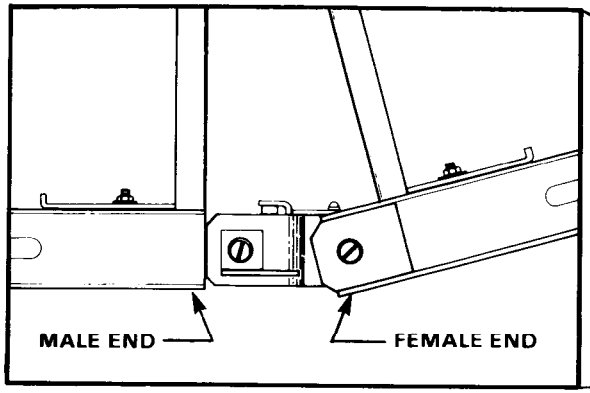
When the far-bank seat is higher than or level with the near-bank seat, launching-nose links must be used to compensate for sag, and the tops of all rollers must be in the same plane. If necessary, block and tackle should be used to prevent the bridge from sliding backwards.

Launching-nose links are necessary if the far-bank seat is low enough to require the use of block and tackle on the near bank to prevent the bridge from running away when the balance point passes the rocking rollers.

Use the following steps to determine the position of launching-nose links:

1 Determine sag from Tables 6-1 through 6-3, 7-1 and 7-2, or 8-1 and 8-2

2 Safety sag of 6 inches (15.27 centimeters)



3 Lift required (LR):
LR = steps 1 + 2

4 Position of launching-nose link (Figure 4-12)

EXAMPLE:
Given a 160-foot (48.8 meters) *triple-single* bridge with grillage type 1 on both the near shore (NS) and far shore (FS). The far-bank seat is level with the near-bank seat.

Problem:
Are launching-nose links required? If links are required, at what distance are they placed from tip of launching nose?

Solution:
Launching-nose links are required. Therefore the following steps are used:

1 Determine sag for 160-foot *triple-single* (Table 6-3)
77 inches (195.58 centimeters)

2 Safety factor of
6 inches (15.24 centimeters)

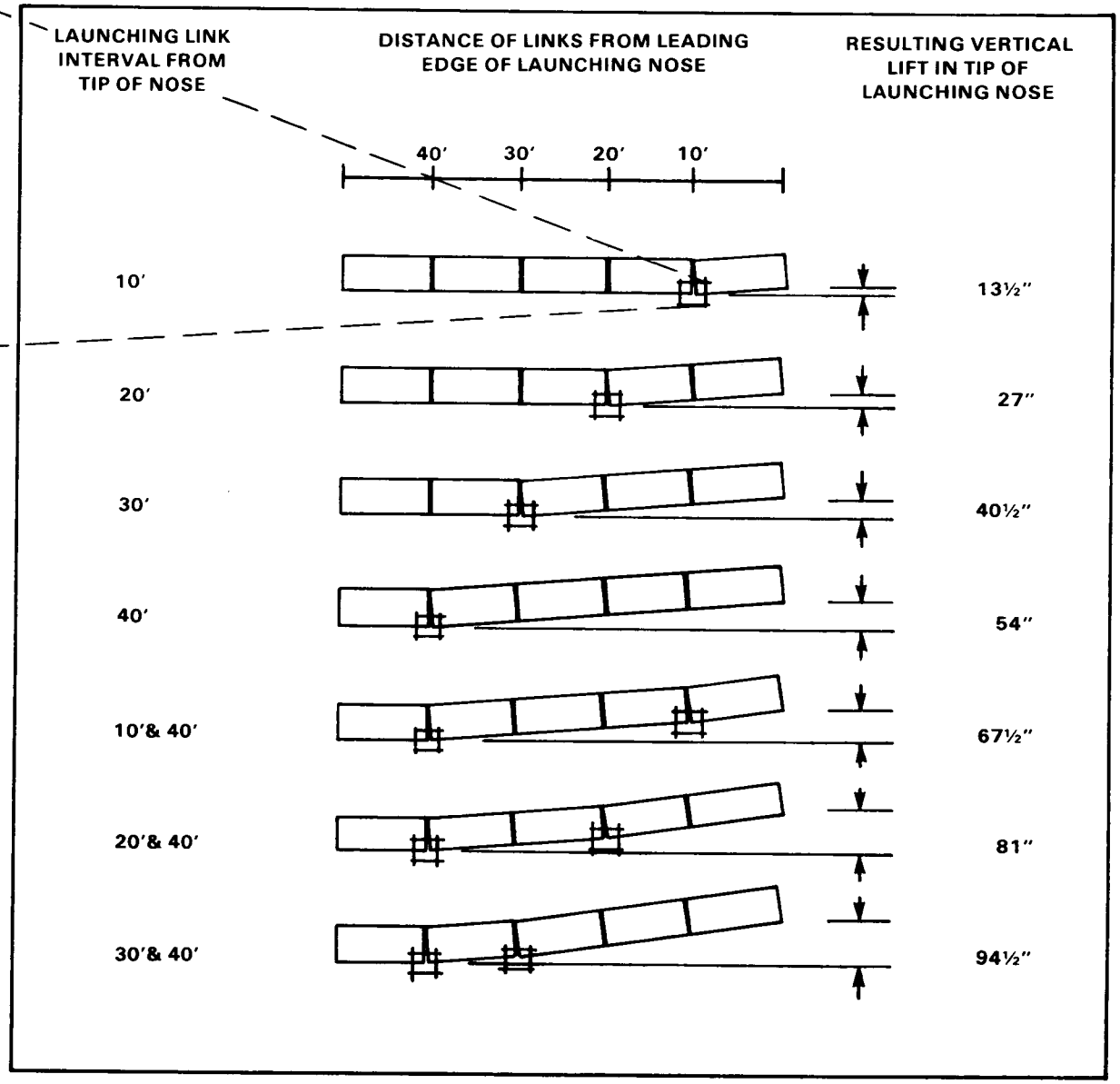


Figure 4-12 ***Upturned skeleton launching nose***

3 Lift required (LR):

LR = (steps 1 + 2)
LR = 77 inches + 6 inches
LR = 83 inches (210.82 centimeters)

4 Position of launching-nose link (Figure 4-12):

Two pairs of launching-nose links placed at 30 feet (9.144 meters) and 40 feet (12.192 meters) from the tip of the nose

Table A-1 in Appendix A gives the number and position of launching-nose links required for normal bridges. This table assumes that both near-and far-shore rocking rollers are at the same elevation.

ROLLERS AND JACKS

ROCKING ROLLERS

Use rocking rollers on both banks during launching. Normally, use two rocking rollers on the near bank for *single-single* and *double-single* truss bridges of 100 feet (30.5 meters) and shorter. Use four for all other assemblies. Two rocking rollers are normally required on the far bank; however, use four if the skeleton launching nose is double-truss in any part. Table 4-6 shows the required number of rocking rollers on near and far banks for various bridge lengths and assemblies.

PLAIN ROLLERS

Place rows of plain rollers behind the rocking rollers at intervals of 25 feet (7.6 centimeters) to support the bridge during construction. The number of rollers in each row depends on the type of bridge. *Single-single* and *double-single* bridges need two plain rollers per row. All other types of construction need four plain rollers per row (Chapter 5). The number of rows required depends on the construction backspace needed. Place plain rollers only every 25 feet (7.6 meters). More rollers are not required to support an overhang under 25 feet (7.6 meters). In addition, two construction rollers are used to aid in inserting the launching-nose links. These are plain rollers placed 12½ feet (3.8 meters) behind the rocking rollers and 2 to 4 inches (5.0 to 10.1 centimeters) below the plane of the other rollers. They may be removed once the construction extends back to the first row of plain rollers. The number of plain rollers needed for various bridges is shown in Table 4-7 (page 52).

JACKS

The number of jacks required to jack down a bridge depends on the span length and the type of the bridge. The number of jacks needed to jack down the end of the bridge is shown in Table 4-8 (page 52). Details on jacking procedures are given in Chapters 6, 7, and 8.

Note: Jacks must be positioned so that they carry no more than 7½ tons (6.8 metric tons) on the toe or 15 tons (13.6 metric tons) on the top.

Table 4-6 Number of rocking rollers needed for bridge

TYPE OF CONSTRUCTION	SPAN (ft)	NEAR BANK	FAR BANK
SS	30-100	2	2
DS	50-80	2	2
	90-100	2	2
	110-140	4	2
TS	80-160	4	2
DD	100-130	4	2
	140-180	4	4
TD	110-120	4	2
	130-190	4	4
DT	130-210	4	4
TT	160-210	4	4

Table 4-7 ***Rows of plain rollers needed for bridge***

SPAN (ft)	TYPE OF CONSTRUCTION SS	DS	TS	DD	TD	DT	TT
30-50	1	1					
60-80	2	2	2				
90	3	2	2				
100	3	3	2	2			
110-120		3	3	3	3		
130		3	3	3	3	3	
140		3	4	4	3	3	
150			4	4	4	4	
160			4	4	4	4	3
170				4	4	4	3
180				4	5	4	4
190					5	5	4
200-210						5	4
NUMBER OF ROLLERS PER ROW	2		4				

NOTE: ALWAYS ADD 2 PLAIN ROLLERS FOR USE AS CONSTRUCTION ROLLERS

Table 4-8 ***Number of jacks needed at each end of bridge***

TYPE OF CONSTRUCTION	SPAN (ft)	JACKS NEEDED AT EACH END OF BRIDGE
SS	30-100	2
DS	50-140	4
TS	80-140	4
	150-160	6
DD	100-120	4
	130-180	6
TD	110-140	6
	150-190	8
DT	130	6
	140-180	8
	190-210	10
TT	160-170	10
	180-210	12

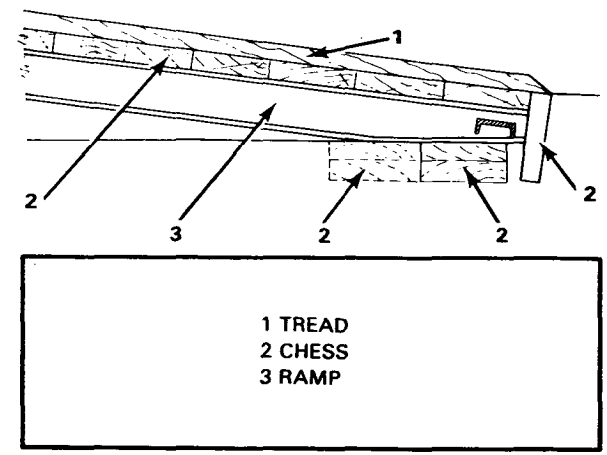


Figure 4-13 ***Support for end of ramp***

RAMP REQUIREMENTS

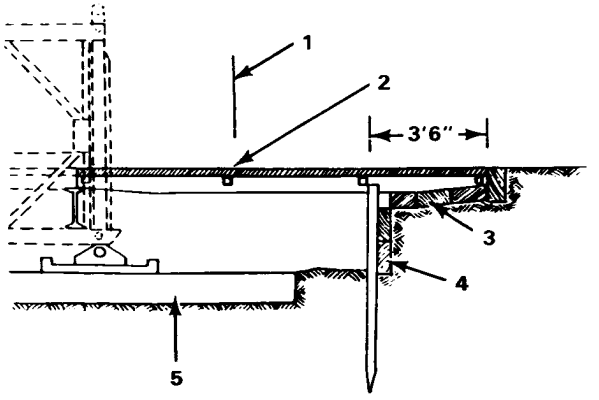
Ramps are used at each end of the bridge. The slope of the ramp must not exceed 10 to 1 for loads up to and including 50 tons, and 20 to 1 for loads over 50 tons.

SUPPORT FOR END OF RAMP

The end of the ramp will carry about one quarter of the weight of the heaviest tracked vehicle to pass over it when the ramp is supported at midspan. If there is no midspan support, the end of the ramp will carry about 40 percent of the weight of the tracked vehicle. One or two stacks of chess, side by side, are laid in two layers under the tapered end of the ramp to provide the necessary bearing area on the soil. If greater area is needed for heavy loads on very soft soil, footings are used under the chess. On soil capable of supporting 2 tons per square foot, two chess under the tapered end of the ramp are enough for bridges up to class 67. For higher capacity bridges, four chess are used (Figure 4-13). One chess on edge at the end of the ramp serves as an end dam, so the approach can be made level with the ramp floor. An alternate method for supporting the ramps on the ground is to use a transom as a sill under the ramp.

MIDSPAN RAMP SUPPORTS

For loads of 45 tons (40.8 metric tons) or over, each ramp section must be supported at its midpoint by cribbing and wedges. This support will carry one half of the class of the vehicle passing over, and the base of the cribbing should be large enough to spread the load over the soil without exceeding the allowable bearing pressure of the soil. On soil capable of supporting 2 tons per square foot, two chess side by side under the cribbing provide enough bearing area for all bridges. An alternative method for loads of 45 tons or more is to make the ramp level with at least 3½ feet (1.07 meters) of the ramp supported on the abutment (Figure 4-14).

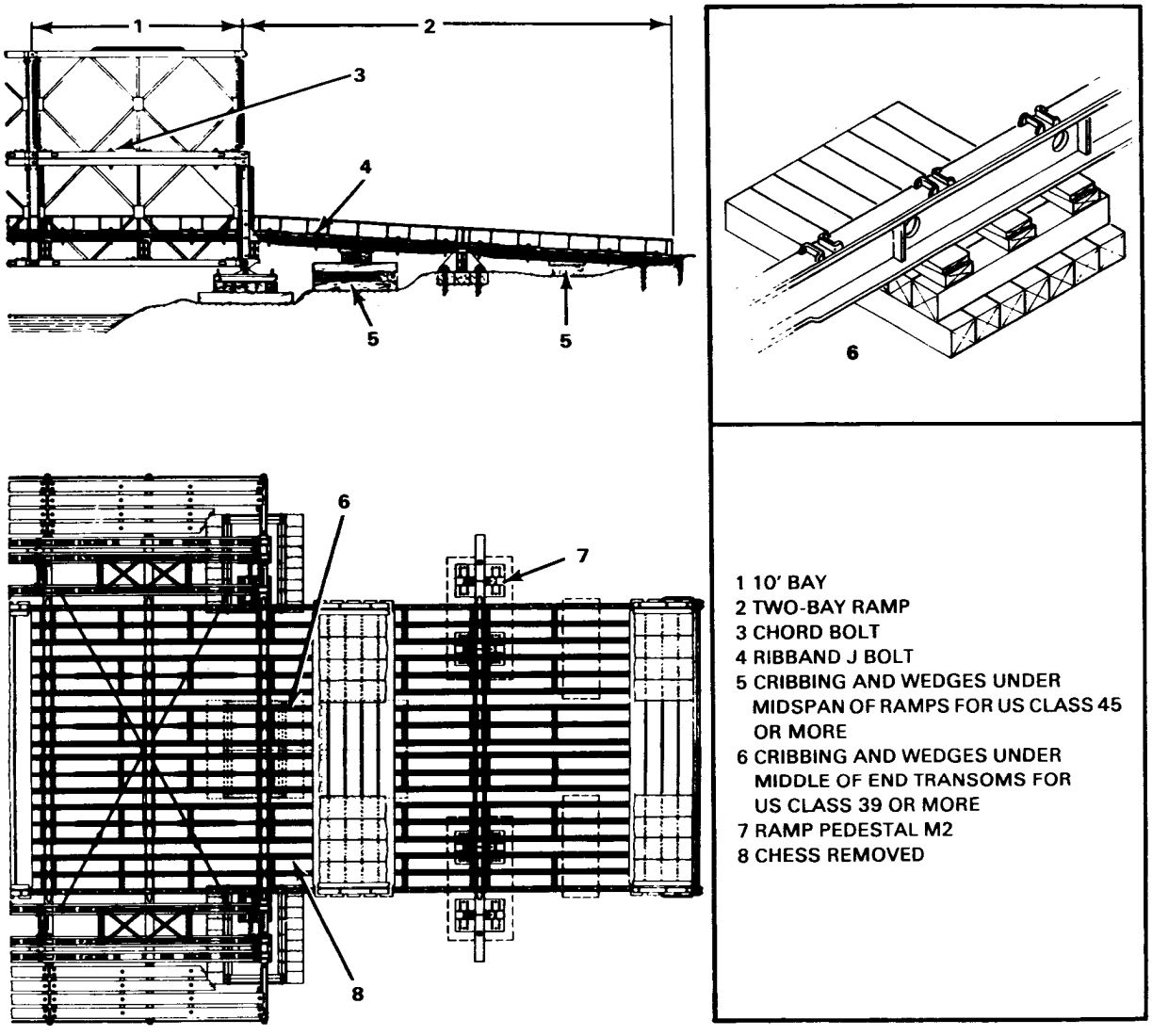


1 FACE OF END DAM HERE WHEN NO GRILLAGE IS USED
2 LEVEL RAMP
3 SLEEPERS
4 END DAM
5 GRILLAGE

Figure 4-14 ***Level 10-foot ramp for loads of 45 tons or over***

PEDESTAL SUPPORTS

Because the slope of the ramp should not exceed 1 to 10, it may be necessary to use two or more ramp bays. The junction of the ramp bays rests on a transom supported by four ramp pedestals spaced as shown in Figure 4-15. These pedestals (Figure 4-16, page 54) take two thirds of the class of the vehicles passing over and must be set on enough grillage to spread the load over the soil. Three 6-by 6-inch (15.2 by 15.2 centimeters) timbers 4 feet 6 inches (1.4 meters) long under each pair of pedestals provide enough area for 40-ton loads on soil that will carry 2 tons per square foot. For heavier loads, three chess are placed side by side under the 6- by 6-inch (15.2 centimeters by 15.2 centimeters) timbers.



1 10' BAY
2 TWO-BAY RAMP
3 CHORD BOLT
4 RIBBAND J BOLT
5 CRIBBING AND WEDGES UNDER MIDSPAN OF RAMPS FOR US CLASS 45 OR MORE
6 CRIBBING AND WEDGES UNDER MIDDLE OF END TRANSOMS FOR US CLASS 39 OR MORE
7 RAMP PEDESTAL M2
8 CHESS REMOVED

Figure 4-15 ***TD panel bridge, Bailey type M2***

SUPPORTS FOR END TRANSOM

For loads of 40 tons (36.3 metric tons) or more, use cribbing and wedges under the midpoint of the end transom. This support will carry 40 percent of the weight of the heaviest tracked vehicle to pass over, and the area of the base of the cribbing should be large enough to spread the load over the ground without exceeding the allowable bearing pressure on the soil. Seven 6- by 6-inch (15.2 centimeters by 15.2 centimeters) timbers 4-feet 6-inches (1.4 meters) long laid side by side provide enough area for all the bridge loads on soil that will carry 2 tons per square foot.

EXAMPLE FIELD DESIGN PROBLEM

MISSION GIVEN: Design a Bailey to span the gap shown in Figure 4-17. Bridge must have Military Load Class (MLC) 60 wheeled/60 tracked. All data required is given in Figure 4-17.

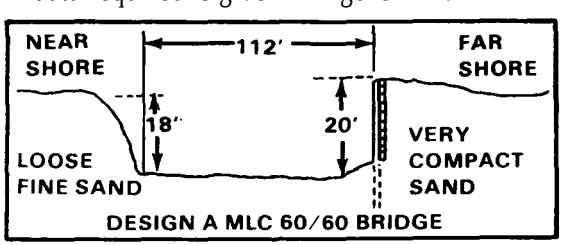


Figure 4-17. Site profile example

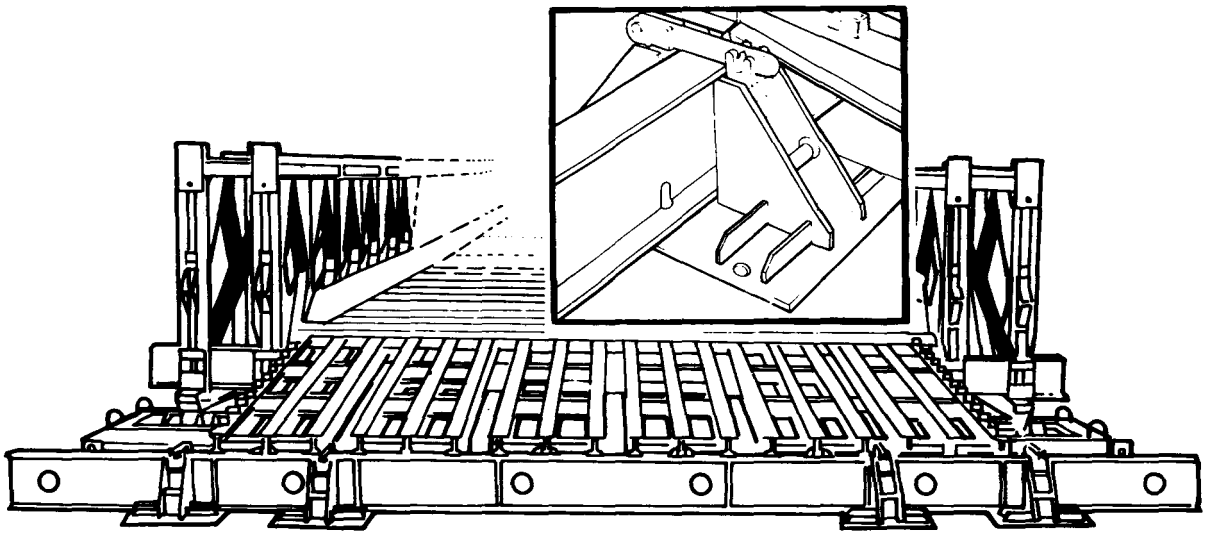


Figure 4-16. Ramp pedestals in place in two-bay ramp

I. INITIAL BRIDGE DESIGN
(Steps 1 through 6)

1. Gap measured during reconnaissance (p 36)
   1. 112'
2. Safety setback. (p 37)
   a. Prepared abutment = constant of 3.5'.
   b. Unprepared abutment = 1.5x bank height.
   2. NS 1.5 x 18' = 27'
      FS 3.5'
3. Initial roller clearance. Always use a constant of 2.5'.
   3. NS 2.5'
      FS 2.5'
4. Initial bridge length.
   a. Add steps 1+2+3.
   4a. 147.5'
   b. If value in step 4a is NOT a multiple of 10, round UP to the next highest 10.
   4b. Ø = 150.0'
5. Initial truss/story type. (Table A-7, p 303)
   5. DT
6. Initial bridge class. (Table A-7, p 303)
   a. Class must meet or exceed the MLC given in the mission.
   b. The truss/story type selected is always based on a NORMAL CROSSING unless otherwise directed by the TACTICAL COMMANDER.
   6. 60/60

II. ADJUSTED/FINAL BRIDGE DESIGN
7. Selection of grillage.
   a. Safe soil bearing. (Table 4-1, p 45)
   7a. NS 2 tons/ft²
      FS 6tons/ft²
   b. Safe soil pressure. (Table 4-4, p 48). If the soil bearing capacity values from step 7a are NOT listed in Table 4-4, round DOWN to the closest value listed. Use these values for step 7c.
   7b. NS 2 tons/ft²
      FS 3.5 tons/ft²

c. Grillage required.

7c. NS Type(s) 4,6,& 7
FS Type(s) 2

8. Determine adjusted bridge length.

a. Distance required for new roller clearance. (Table 4-5, p 49)

8a. NS 4.5'
FS 4.5'

b. Add steps 1+2+8a.

8b. 151.5'

c. If value in step 8b is NOT a multiple of 10, round UP to the next highest 10.

8c. Ø = 160.0'

NOTE: Compare the value in step 8c to the value in step 4b. If different, you must redesign the bridge as outlined in steps 9 through 12, using length from step 8c to find truss type in step 9. If not, use this as your final bridge length and go to step 13.

FINAL BRIDGE	
TRY 1	TRY 2

9. Final truss/story type. (Table A-7, p 303)

9. TT | DT

10. Final bridge class. (Table A-7, p 303)

a. Class must meet/exceed the MLC given in the mission.

b. The Truss/Story Type selected is always based on a NORMAL CROSSING unless otherwise directed by the TACTICAL COMMANDER.

10. 80/75 | 60/60

11. Final grillage selection.

a. Safe soil bearing. (Table 4-1, p 45)

11a. NS 2 tons/ft^2 | 2 tons/ft^2
FS 6 tons/ft^2 | 6 tons/ft^2

b. Safe soil pressure. (Table 4-4, p 48). If the soil bearing capacity values from step 11a are NOT listed in Table 4-4, round DOWN to the closest listed. Use these values for step 11c.

11b. NS 2 tons/ft^2 | 2 tons/ft^2
FS 3.5 tons/ft^2 | 3.5 tons/ft^2

c. Grillage required.

11c. NS Type(s) 6 & 7 | 4,6, & 7
FS Type(s) 6 & 7 | 3

12. Determine final bridge length.

a. Distance required for new roller clearance. (Table 4-5, p 49)

12a. NS 3.5' | 3.5'
FS 3.5' | 3.5'

b. Add steps 1+2+12a.

12b. 149.5' | 149.5'

c. If value in step 12b is NOT a multiple of 10, round UP to the next highest 10.

12c. Ø = 150.0' | Ø = 150.0'

NOTE: (1) FOR TRY 1: Compare the value in step 12c to the value in step 8c.

a. If the same, go to step 13.

b. If different, compare this value (step 12c) to the value in step 4b:

1. If these are the same, the designer is placed in a judgmental situation. Repeating the design sequence under the "TRY 2" column using the bridge length from step 12c of "TRY 1" column will place you in an endless circle unless the final bridge length can be reduced. In these cases, one will have to use common sense and either overdesign a longer final bridge as shown in the "TRY 1" column or choose a higher number grillage than that originally selected in step 7c. The latter procedure could reduce the roller clearance on one or both banks so that the required bridge length/final truss-story may be at the minimum to do the job. You may choose a higher number grillage than allowed within step 11c; however, you must be careful not to exceed the BP and RRT capacities listed in Table 4-2, p 46 and Table 4-3, p 47, FM 5-277. Make your decision and go to step 13. In this example problem, the designer chose to select Type 3 grillage for the FS. Since this was not an option within step 11c he had to look at Tables 4-2 and 4-3 under a 150' DT bridge with a safe soil pressure of 3.5 tons/ft^2 to see if the BP and RRT capacities were exceeded:

Table 4-2	Table 4-3
BP Reaction	BP Allowable
= 55 tons	= 61 tons OK
RR Reaction	RRT Allowable
= 54.8 tons	= 60 tons OK

Had the designer not accomplished this, he would have been forced to build the 160' TT bridge shown under the "TRY 1" column and wasted a lot of assets.

2. If these are different, you must redesign the bridge by entering the "TRY 2" column with the bridge length from step 12c "TRY 1" to determine the truss/story type in step 9.

NOTE: (2) FOR TRY 2 and HIGHER: Compare this value in step 12c to the value in step 12c of the previous "TRY" column. If the same, go to step 13. If different, use the same methodology and repeat the design sequence until the value obtained in a particular step 12c matches the value in step 12c of the previous design. Go to step 13.

13. Slope check. (p 45)

a. The maximum allowable bank height difference is 1 in 30. Therefore, maximum allowable bank height difference = final bridge length + 30.

13a. 150+30 = 5 2

b. If:

(1) The step 13a value ≥ actual bank height difference the slope is all right.

(2) The step 13a value < bank height difference

(a) Choose another site,

OR

(b) Crib up/excavate the FS or NS until the bridge slope is within limits.

13b. (GO)/NO GO(circle one)

REMARKS:

14. Final bridge requirements:

Length 150'

Truss/Story Type DT

Class 60/60

Grillage: NS Type 6

FS Type 3

15. Launching nose composition. (Tables 6-1 through 6-3, p 64/65, Tables 7-17-2, p 95, or Tables 8-1/8-2, p 104, dependent upon truss type)

15. 9 Bays (5 Sgl Truss/4 Dbl Truss)

16. Placement of launching nose links.

a. Sag. (See tables as in step 15)

16a. 34"

b. Safety sag. (Constant of 6")

16b. + 6"

c. Lift required. (Add steps 16a + 16b)

16c. = 40"

d. Position of launching nose links (Figure 4-12, pg 50)

16d. 30' from tip of nose

17. Rocking rollers needed. (Table 4-6, pg 51)

17. NS 4

FS 4

18. Plain rollers needed.

a. SS and DS bridges ONLY have two rollers per row. All others have four rollers per row. Use Table 4-7 to determine the number of rows then multiply.

18a. 4x4= 16 rollers

b. Add two more plain rollers to allow for your construction rollers.

18b. + 2

c. Add steps 18a to 18b.

18c. = 18 rollers

19. Jacks required. (Table 4-8)

19. 8 jacks

NOTE: Only one end of the bridge will be jacked down at any onetime.

20. Ramp requirements.

a. Slope requirements (check one)

(1) Final bridge class ≤ 50= 1 to 10 ( ).

(2) Final bridge class > 50 = 1 to 20 (x)

b. Support for end ramp (check one)

(1) Final bridge class ≤ 67 = 2 Chess (x).

(2) Final bridge class > 67 = 4 Chess ( )

c. Midspan ramp supports (check one)

(1) Final bridge class ≤ 44 = Not needed ( ).

(2) Final bridge class > 44 = Needed (x)

d. Pedestal supports (check one)

(1) Not needed ( )

(2) Needed (x)

NOTE: See Page 53 for criteria and drawings. Ramp length must be estimated from the site sketch.

e. Support for end transoms (check one)

(1) Final bridge class ≤ Class 39 = Not needed ( ).

(2) Final bridge class > Class 39 = Needed (x)

21. Personnel required. (Table 3-2, p 33)

21. 7/122 w/o Crane 7/97 with Crane

NOTE: Check the difference between manpower only and crane construction.

22. Assembly time. (Table 3-3, p 34)

22. 13 1/4 hrs w/o Crane/ 11 3/4 w/Crane

BRIDGE CLASSIFICATION

CLASSIFICATION OF EXISTING BRIDGES

Bailey bridge classifications may be determined by entering Table A-6 in Appendix A with the span length and truss type. This will give the classification of the bridge for normal, caution, and risk crossings. Table 4-9 gives restrictions for the types of crossing.

Notes: The caution class number is found by test and is normally 25 percent greater than the normal class. Risk loads will probably cause permanent deformation of bridge parts and may result in failure if repeated. Therefore, the engineer officer must thoroughly check the condition of the bridge before and after such a crossing. The grillage, cribbing, and number of transoms per bay must also be checked and the bridge class reduced or upgraded to obtain the required classification. The condition of the bridge and its supports must also be considered in its classification. If the bridge is deformed or damaged, the grillage has rotted, or the abutment has failed, the bridge classification must be drastically lowered.

Table 4-9 ***Bailey bridge crossing restrictions***

	TRAFFIC RESTRICTIONS		
	NORMAL	CAUTION	RISK
Vehicle position	Anyplace on deck	On centerline of deck	On centerline of deck
Max speed	25 mph	8 mph	3 mph
Operation	No sudden stopping, or accelerating	No stopping, accelerating, or gear shifting	No stopping, accelerating, or gear shifting; tanks steer by clutch only
Min spacing	30-yd tail-to-head convoy spacing	50-yd tail-to-head	One vehicle on bridge at a time
Authority to use	Anyone	Tactical area commander (normally corps or higher)	

EXAMPLE:

Given:

Bridge length—80 feet (24.4 meters)

Truss type—*double-single*

Grillage—none

Soil-bearing capacity—10 t/sf

Cribbing—none

Condition—excellent

Required:

Determine the normal track classification of the bridge without upgrading

Solution:

Take the following steps:

1 Class—55 track (from Table A-6 in Appendix A)

2 Grillage—install type 1 as a minimum (Table 4-4)

3 Cribbing

Midspan ramp supports
None—limits class to 44 tons (39.9 metric tons)

End transoms
None—limits class to 39 tons (35.4 metric tons)

4 Condition—excellent, no reduction

5 Final classification—39 track. The overall classification is determined by the lowest classification of steps 1 and 3.

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CHAPTER 5
ROLLER LAYOUT

This chapter describes the longitudinal and lateral spacing of rocking rollers and plain rollers. The elevation of rollers and base plates, as well as a simple method of leveling and placing rollers, is discussed.

LAYOUT OF ROCKING ROLLERS

Establish the longitudinal location of the rocking rollers by the safety setback determined in the field design of the bridge. To determine the lateral spacing, place a rocking roller (Figure 5-1, page 58) on each side of the bridge 7 feet 5 inches (2.26 meters) from the centerline (Figure 5-2, page 58). This gives a constant value of 14 feet 10 inches (4.52 meters) between the centers of the rocking rollers. Most bridges are double- or triple-truss and need another set of rocking rollers (Figure 5-3, page 59) placed 1 foot 6 inches (.46 meter) out from each of the first set of rocking rollers (Figure 5-4, page 59).

Rocking-roller templates have been made which help the proper 1-foot 6-inch (.46 meter) center-to-center spacing of the rocking rollers. On the interior side of these templates, small-angle iron lugs are attached to aid roller spacing. The edge-to-edge spacing of the rocking-roller templates (lug to lug) is 11 feet 6½ inches (3.51 meters) (Figure 5-4). The lugs are, however, frequently lost through use and the most accurate method of spacing the rollers is to use the 14-foot 10-inch (4.52 meters) constant. The Bailey bridge transom is manufactured with a small hole in its center web and two dowel holes toward each end. These holes can be used to properly space the rocking rollers, as shown in Figure 5-5 (page 60).

LAYOUT OF PLAIN ROLLERS

To determine longitudinal spacing, place two or more plain rollers every 25 feet (7.6 meters) behind the rocking rollers to support the bridge during assembly and launching. Place temporarily an extra set of plain rollers (called construction rollers) 12½ feet (3.8 meters) behind the rocking rollers. The construction rollers aid in inserting the launching-nose links and provide clearance between the links and the ground. Remove these construction rollers after the links have passed over the rocking rollers.

To determine lateral spacing, for single-story, single- and double-truss bridges, place two plain rollers one on each side of the centerline every 25 feet (7.6 meters). The center-to-center roller spacing is 14 feet 10 inches (4.52 meters) or 7 feet 5 inches (2.26 meters) each side of the centerline. Plain rollers are normally placed on plain-roller templates which increase the bearing area over the ground. These templates also aid in the lateral spacing of the rollers. The templates are equipped with angle iron lugs, like the rocking-roller templates. Place the template so the lugs face the centerline. The distance between lugs, then, is 11 feet 6½ inches (3.51 meters) (Figure 5-6, page 60).

For all other assembly types use four plain rollers every 25 feet (7.6 meters), two on each side of the centerline. Each plain roller consists of two small independent rollers. For triple-truss or multistory bridges, place the inside plain rollers so that the inside truss will rest upon the second small roller (Figure 5-7, page 60). The spacing between the centers of these small rollers, then, is 14 feet 10 inches (4.52 meters). Place the other set of plain rollers so that the second truss will rest on the first small rollers of this set (Figure 5-7). The distance between these trusses is 1 foot 6 inches (.46 meter). The third truss will rest on the outermost small roller. Plain-roller templates also aid in lateral spacing of the plain rollers for the triple-truss or multistory bridges. Use one template under each roller. Place two templates end to end on each side of the centerline, with the angle iron lugs of the inside templates facing center and the outside lugs facing away from center. When the spacing between the inside lugs is 10 feet 10⅜ inches (3.31 meters), the plain rollers will be at the proper spacing (Figure 5-7).

BASE PLATES

Establish, by the type of grillage required, longitudinal spacing between the center of the rocking rollers and the center of the base plate. The grillage type is determined as described in Chapter 4. To establish lateral spacing, place the base plates under the trusses as shown in Figure 5-9 (page 61).

Space the bearings on the base plates (under the trusses), as shown in Figures 5-8 (page 61) and 5-9.

GRILLAGES

Figures 4-5 through 4-11 show the size of the areas to be leveled off to accommodate the grillages. Take care that the rocking rollers and base plates are properly positioned when placed on the grillage. The grillage can be cribbed up or dug in as needed for leveling.

ELEVATION OF ROLLERS AND BASE PLATES

Set the base plates at an elevation to keep the slope of the ramp bays less than 10 to 1. Also, allow for the depth of wear tread. Set all rollers (both plain and rocking), except the construction rollers, so their tops are in the same horizontal plane. Normally this plane is level, but a slight inclination, not to exceed 30 to 1 slope along the line of the bridge, is permissible. Set the construction rollers 2 to 4 inches (5.1 to 10.1 centimeters) below the level of the other rollers. Placing the far-bank rocking rollers a few inches lower than the plane formed by near-bank rollers allows for near-bank settlement caused by bridge weight.

PLACEMENT CONTROL LINES

A simple method of leveling and placing rollers is the use of placement control lines. The bridge centerline is first placed and extended 25 feet (7.6 meters) on the far shore and the length of the bridge and launching nose on the near shore. Then position two placement control lines parallel to and 7 feet

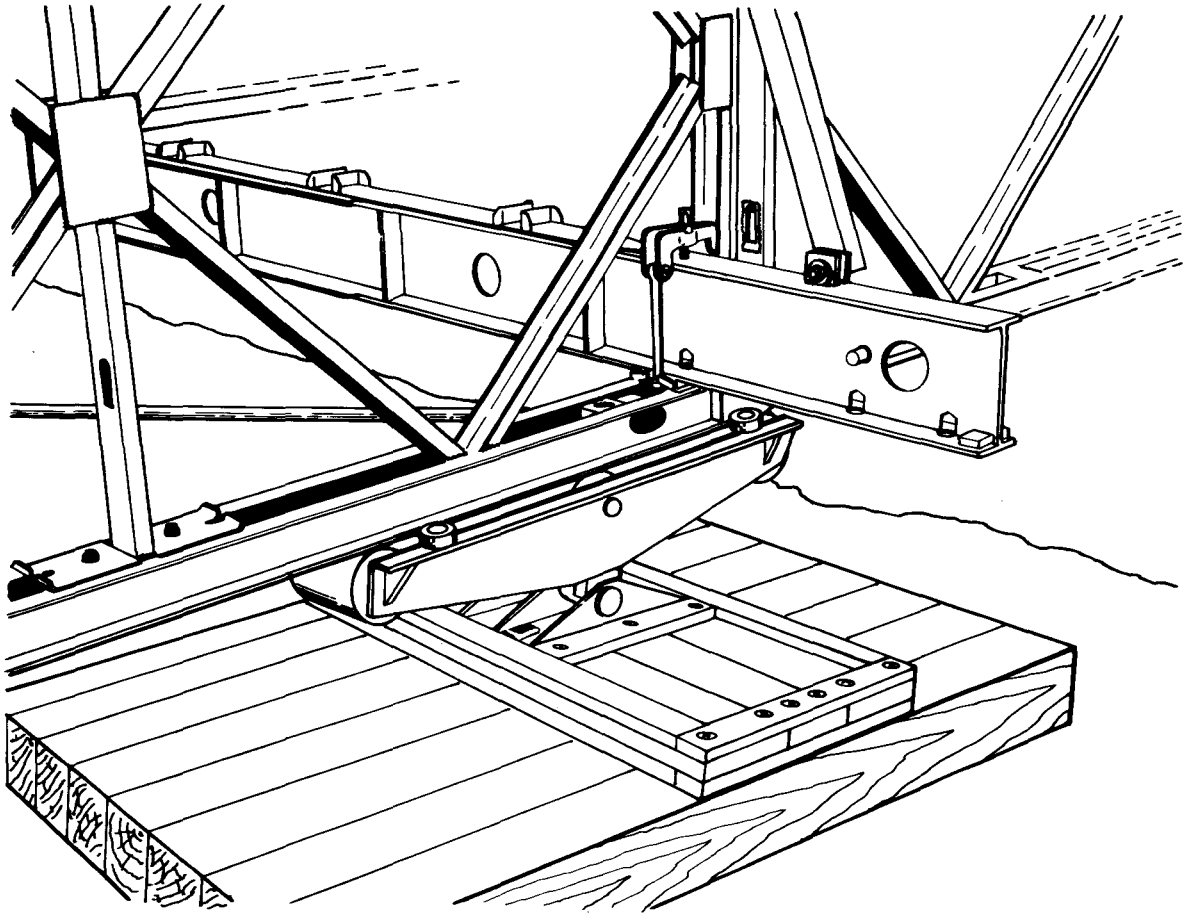


Figure 5-1 ***Single truss on rocking roller***

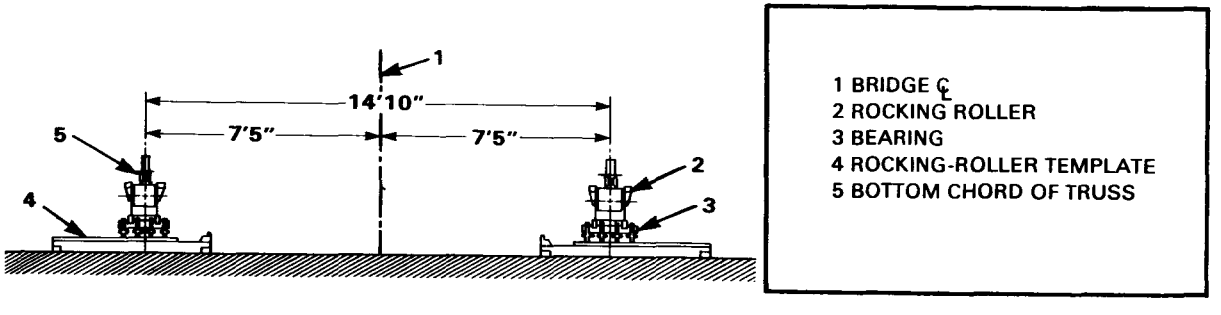


Figure 5-2 ***Lateral spacing of rocking rollers—one set***

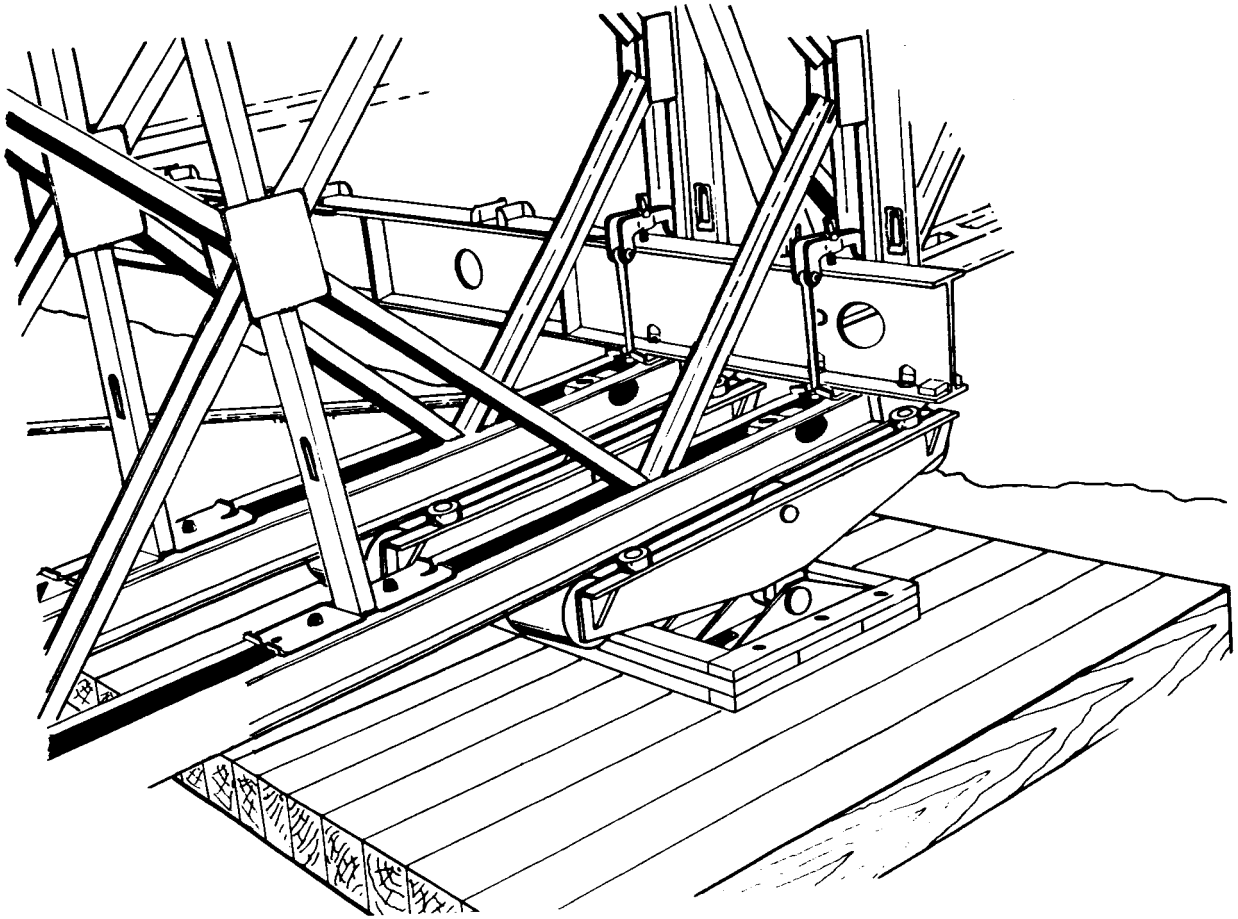


Figure 5-3 ***Double truss on two rocking rollers***

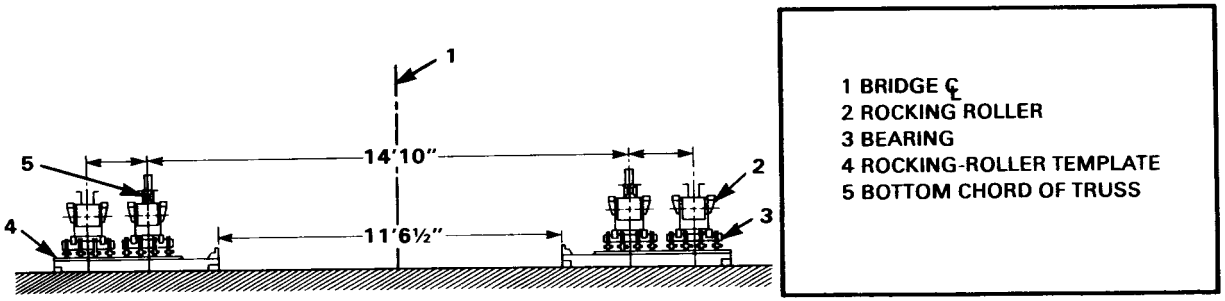


Figure 5-4 ***Lateral spacing of rocking rollers****—two sets*

5 inches (2.26 meters) to either side of the centerline. Position the placement control lines level with the proposed plane of the rollers. Use line levels at several spots on the placement control lines to ensure that they are level. It is also important to ensure that the placement control lines are parallel to the centerline. The rollers can then be cribbed up or dug in as needed to bring their tops to the level of the placement control lines (Figure 5-10, page 62).

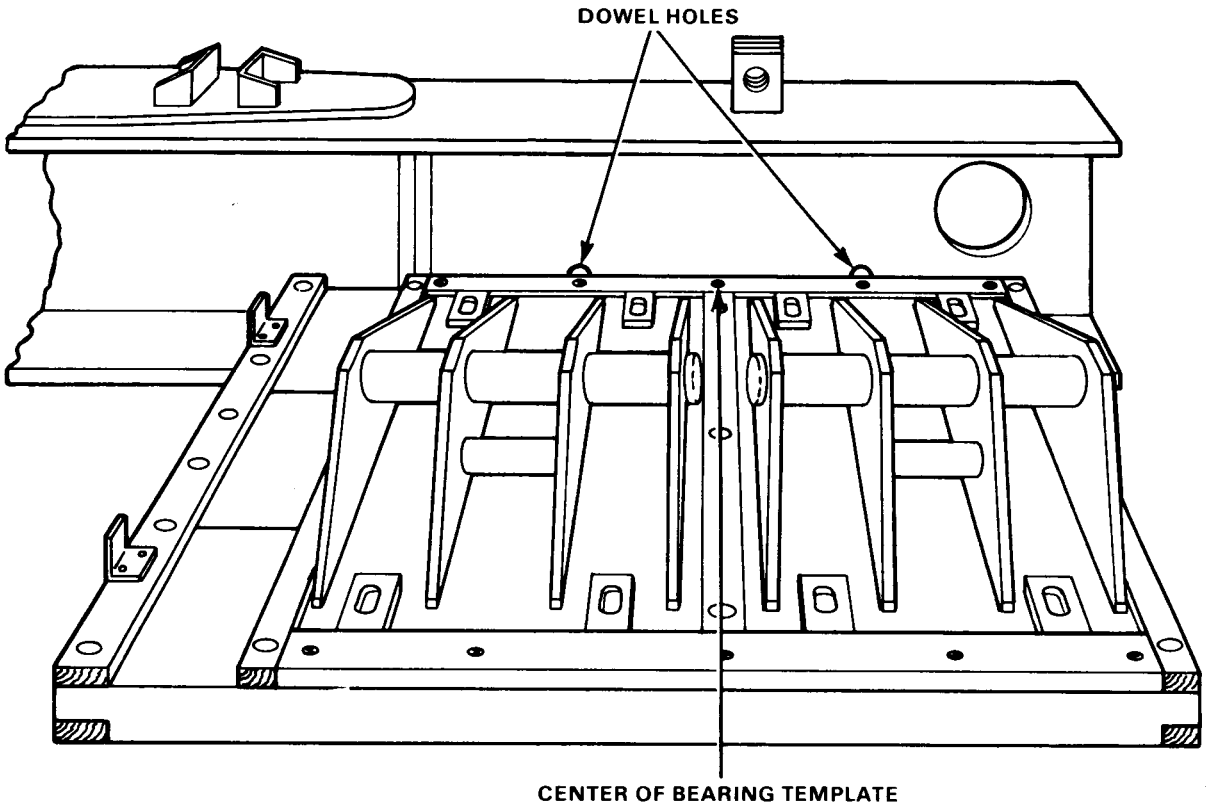


Figure 5-5 ***Use of transom to determine lateral spacing for rocking rollers or base plates***

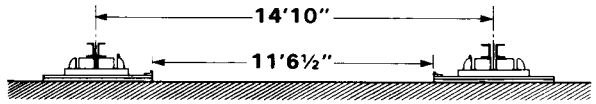


Figure 5-6 ***Lateral spacing of plain rollers for SS and DS Bailey bridges***

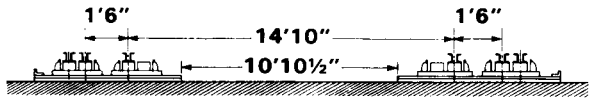


Figure 5-7 ***Lateral spacing of plain rollers for triple-truss and multistory Bailey bridges***

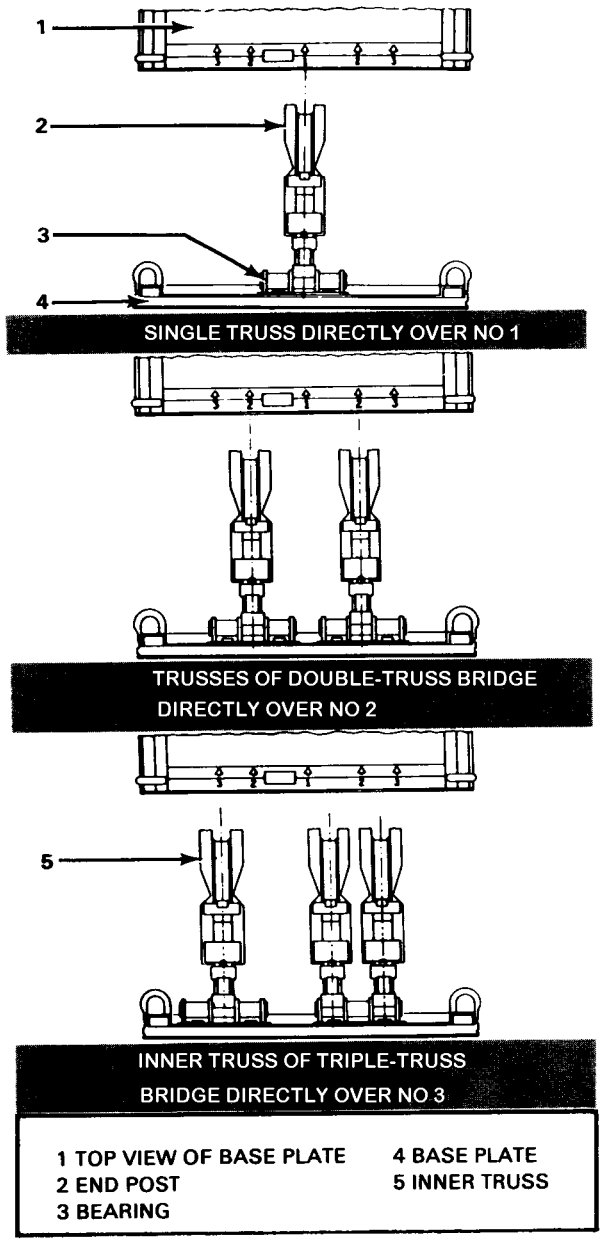


Figure 5-8 ***Use of base plate and bearings under single-, double-, and triple-truss bridges***

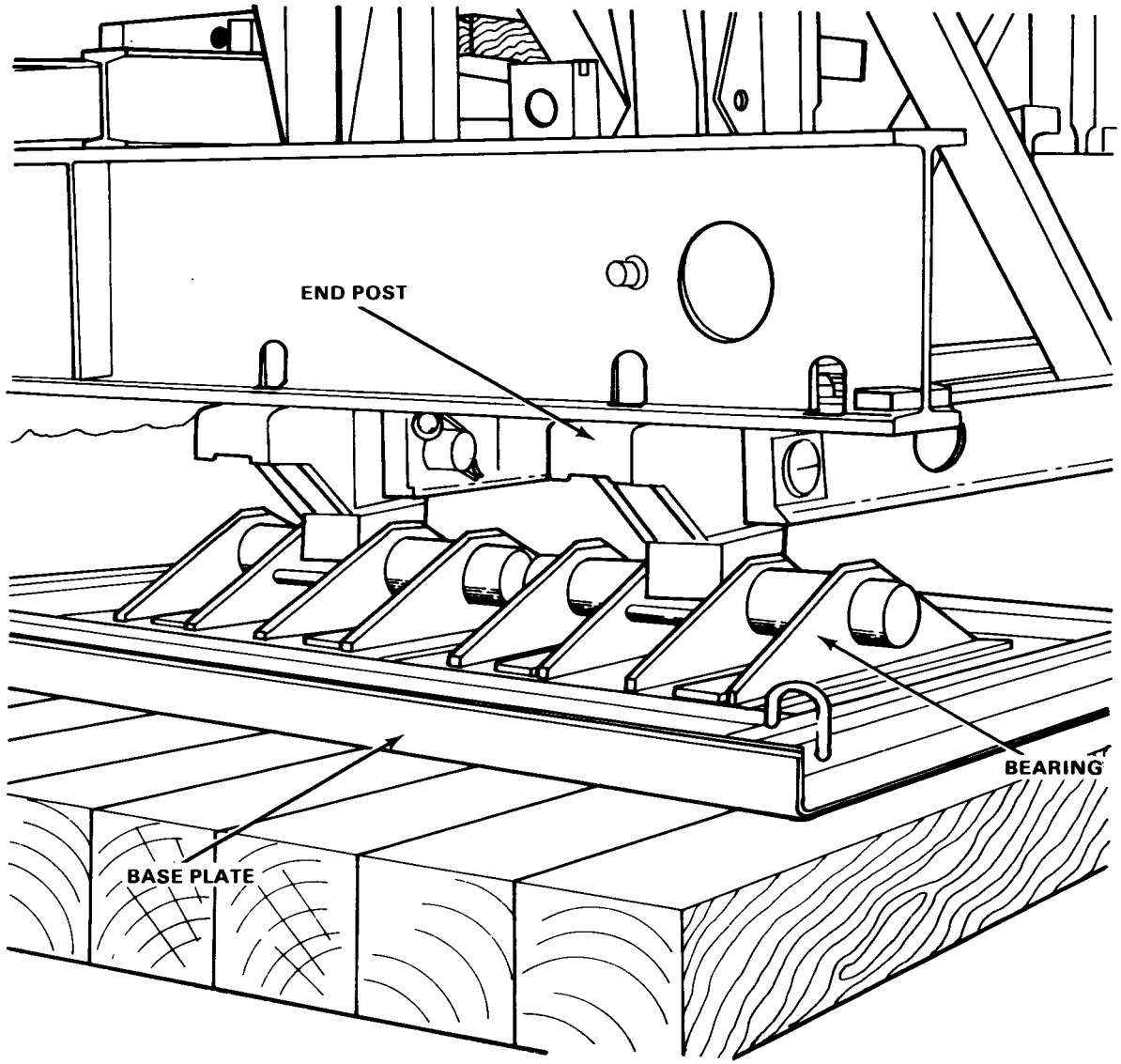


Figure 5-9 ***End posts resting on bearings in double-truss bridge***

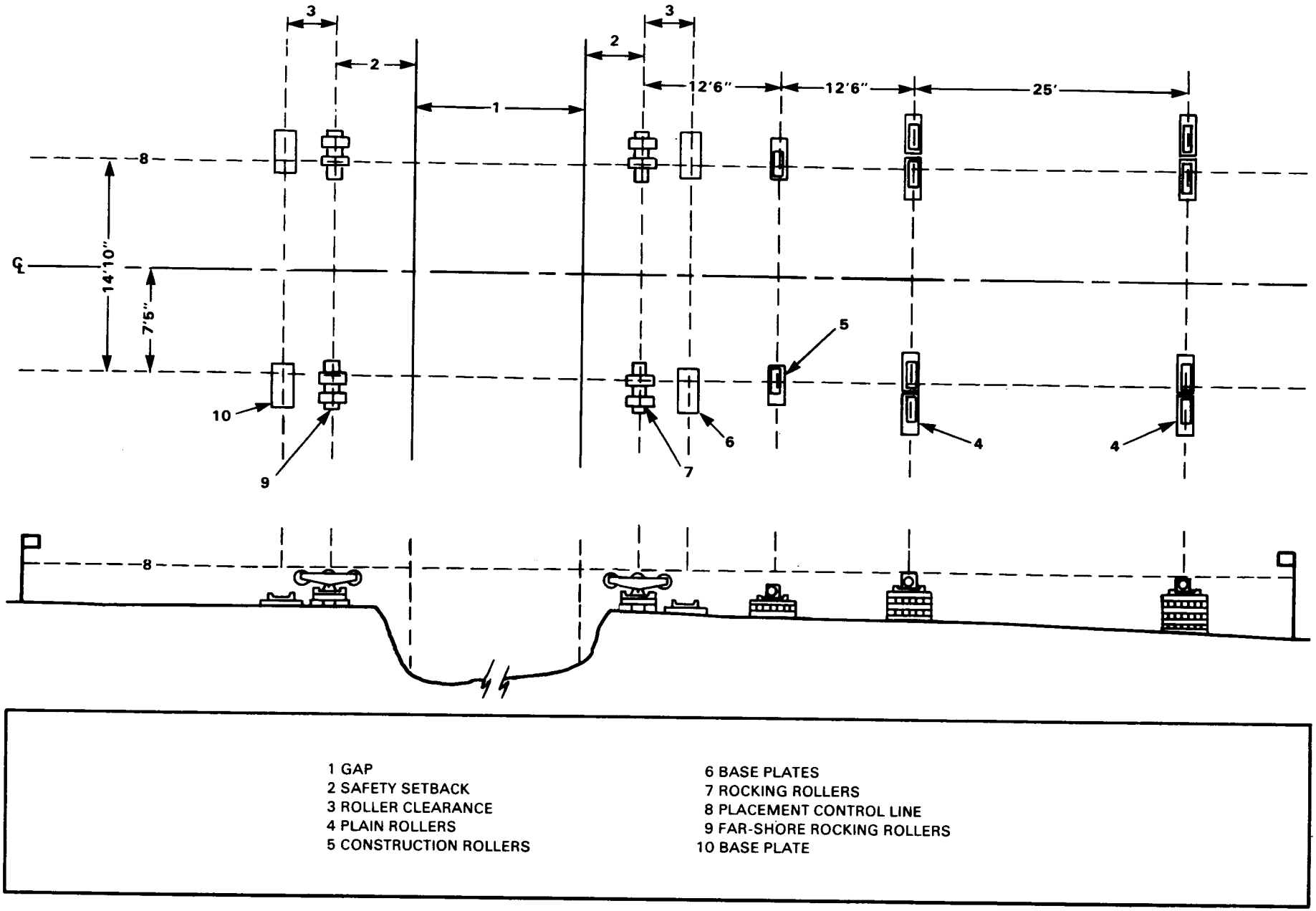


Figure 5-10 ***Plan and profile views of a typical roller layout for a triple-truss or multistory bridge***

CHAPTER 6
ASSEMBLY OF SINGLE-SINGLE BRIDGES

LAUNCHING NOSE 64
ASSEMBLY OF DOUBLE-SINGLE BRIDGE 71
ASSEMBLY OF TRIPLE-SINGLE BRIDGE 83
LAUNCHING, JACKING DOWN, AND RAMPING 85
REINFORCING BRIDGE AND CONVERTING BRIDGE 91

This chapter describes the assembly and composition of double-truss single-story and triple-truss single-story bridges and their respective launching noses. The assembly of single-truss single-story bridges, which have little carrying capacity, is the same as that for the launching nose (Figure 6-l). This chapter also covers the launching, jacking down, and ramping of these bridges. The procedure for adding extra trusses to increase the class of single- and double-truss bridges is also covered.

Single-story bridges are normally assembled and launched by manpower. They can be assembled on the rollers and launched or the bridge and nose can be pushed out over the gap after every two bays are assembled.

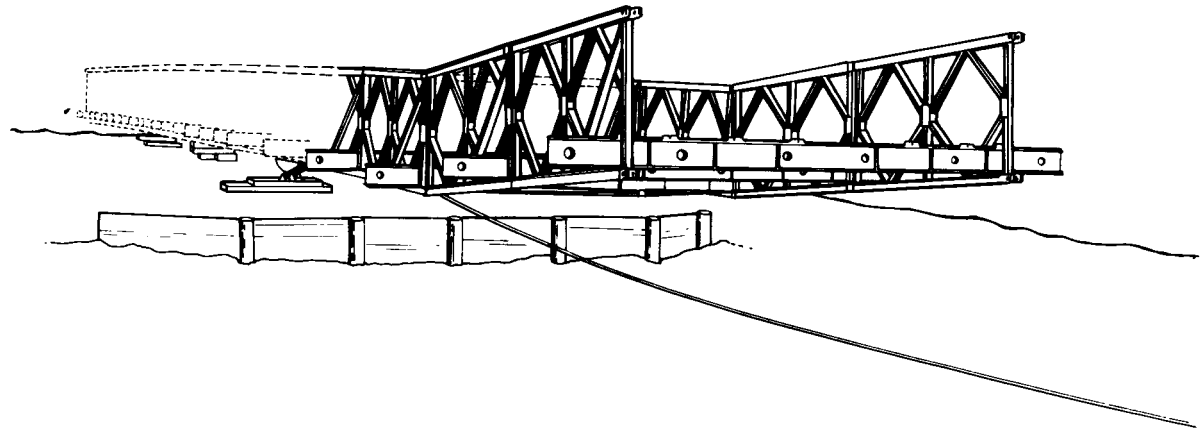


Figure 6-1 ***Launching nose***

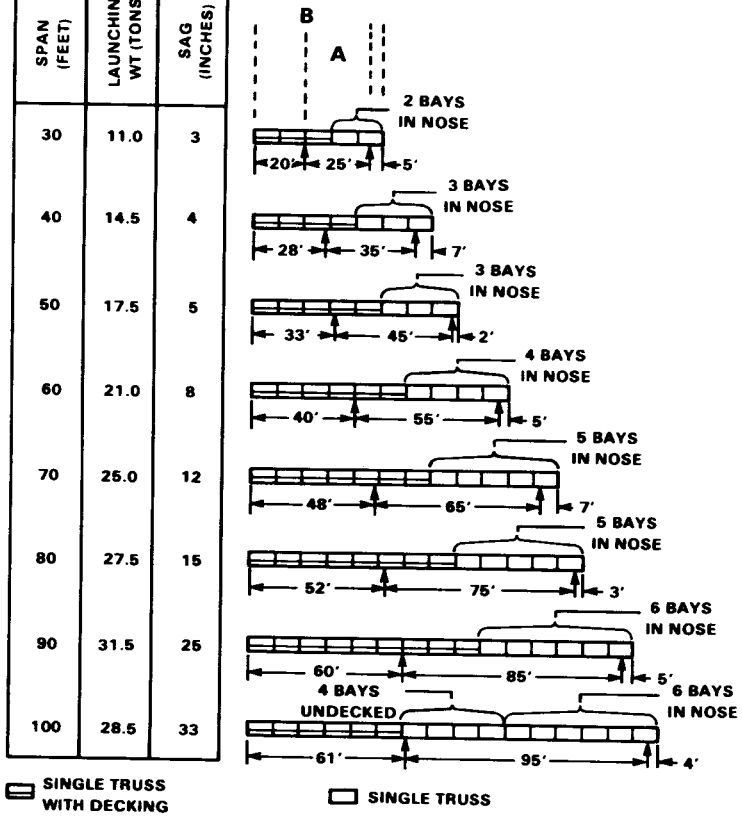
LAUNCHING NOSE

COMPOSITION

The number and types of bays used in the nose depend on the length and truss type of the bridge. The composition of the launching nose for the various lengths of the single-story bridge is given in Tables 6-1 through 6-3. These tables must be followed exactly with respect to the composition of the launching nose. Assembly of the launching nose is the same for all three types of single-story Bailey bridges.

Table 6-1 ***Launching-nose composition for SS bridges***

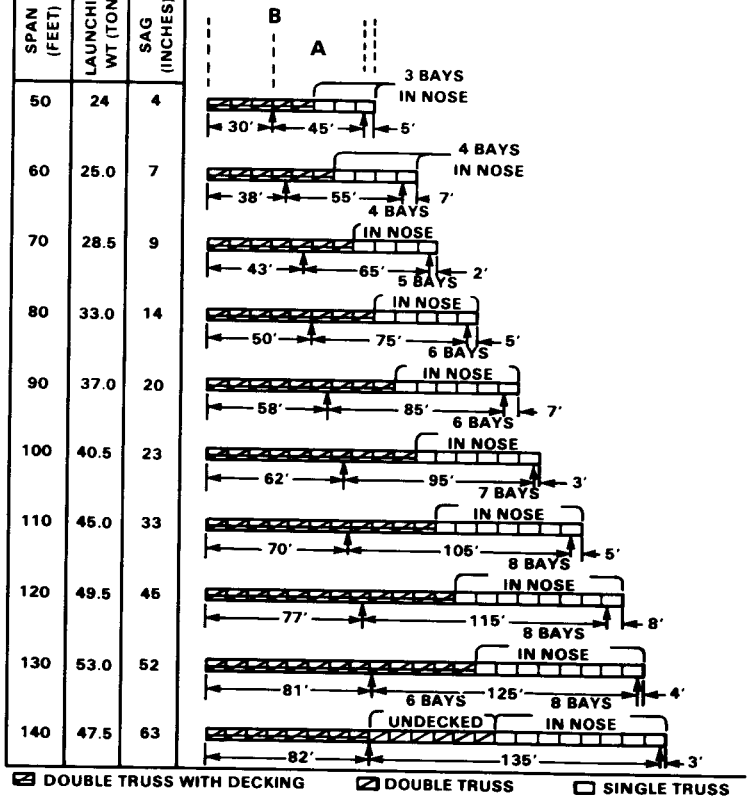
SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
30	11.0	3
40	14.5	4
50	17.5	5
60	21.0	8
70	25.0	12
80	27.5	15
90	31.5	25
100	28.5	33



Notes:
A = Distance between near and far bank rocking rollers
B = Balance point of bridge, ready for launching

Table 6-2 ***Launching-nose composition for DS bridges***

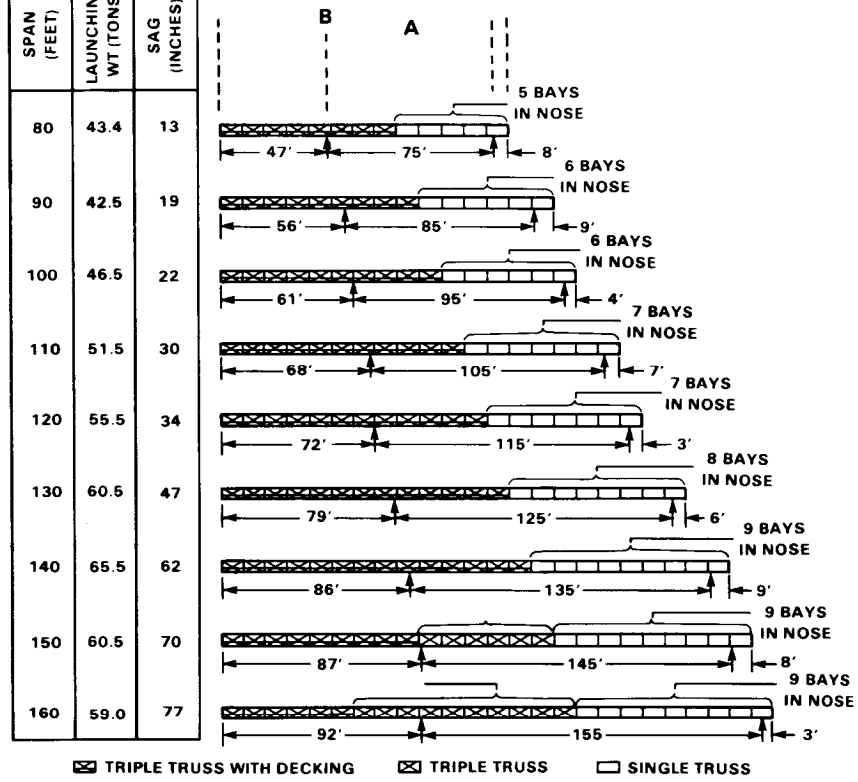
SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
50	24	4
60	25.0	7
70	28.5	9
80	33.0	14
90	37.0	20
100	40.5	23
110	45.0	33
120	49.5	46
130	53.0	52
140	47.5	63



Notes:
A = Distance between near and far bank rocking rollers
B = Balance point of bridge, ready for launching

Table 6-3 ***Launching-nose composition for TS bridges***

SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
80	43.4	13
90	42.5	19
100	46.5	22
110	51.5	30
120	55.5	34
130	60.5	47
140	65.5	62
150	60.5	70
160	59.0	77



Notes:
A = Distance between near and far bank rocking rollers
B = Balance point of bridge, ready for launching

ASSEMBLY AND LAUNCHING

After roller layout is complete, proceed with assembling and launching of nose as follows:

1 Place two panels (female ends forward and male ends resting on construction roller) on the ground directly behind the rocking rollers. Clamp the transom to the panel behind the forward uprights. Secure rakers to transom and panel with bracing bolts (Figure 6-2, page 66).

2 Connect second bay (Figure 6-3, page 67). Insert panel pins (points outward) with grooves in the heads of pins horizontal. Clamp transom to panels behind forward uprights.

3 Place pair of sway braces in second bay.

4 Lift front end of assembled bays onto rocking rollers (Figure 6-4, page 68) and secure with steel pickets through bottom chord of panels and rocking rollers (Figure 6-5, page 69) to prevent rolling.

An alternative method (for rocking rollers on low cribbing) is as follows:

a Assemble first bay on ground.

b Lift front end of bay onto rocking rollers (Figure 6-6, page 70) and secure with steel pickets.

c Raise rear end and slide construction rollers under it 2 inches (5.1 centimeters) below plane of tops of rollers. This places construction rollers approximately 9 feet (2.7 meters) from rocking rollers.

d Add second bay.

5 If required, place launching-nose links in position between panels as determined by assembly conditions. See Chapter 4 to determine the number of links and their position in the nose.

6 Continue adding panels with a transom every 10 feet (3.0 meters). Add sway braces in every bay and rakers on every transom until the required amount of skeleton is built.

Notes

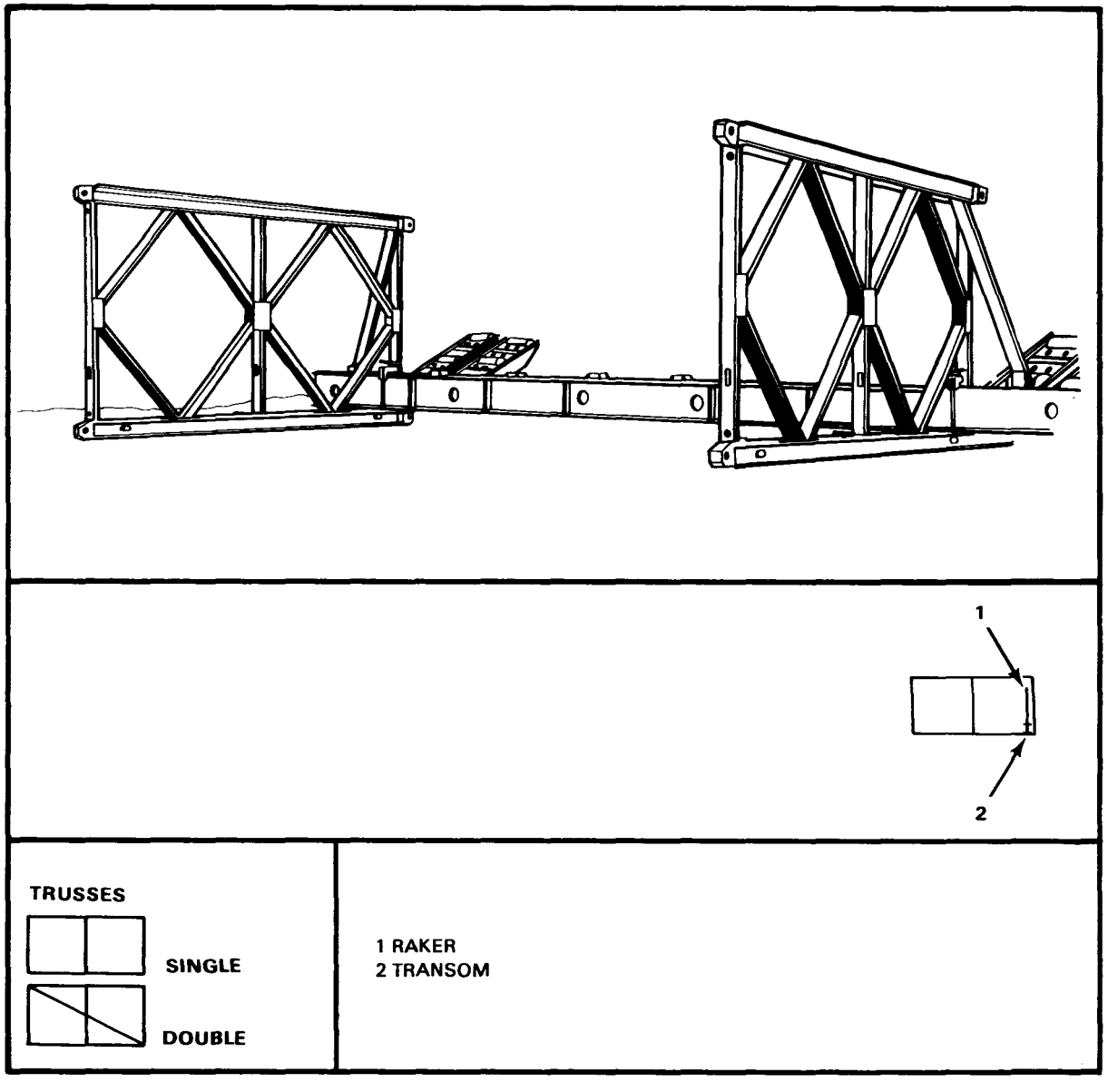


Figure 6-2 Launching nose, initial bay assembled

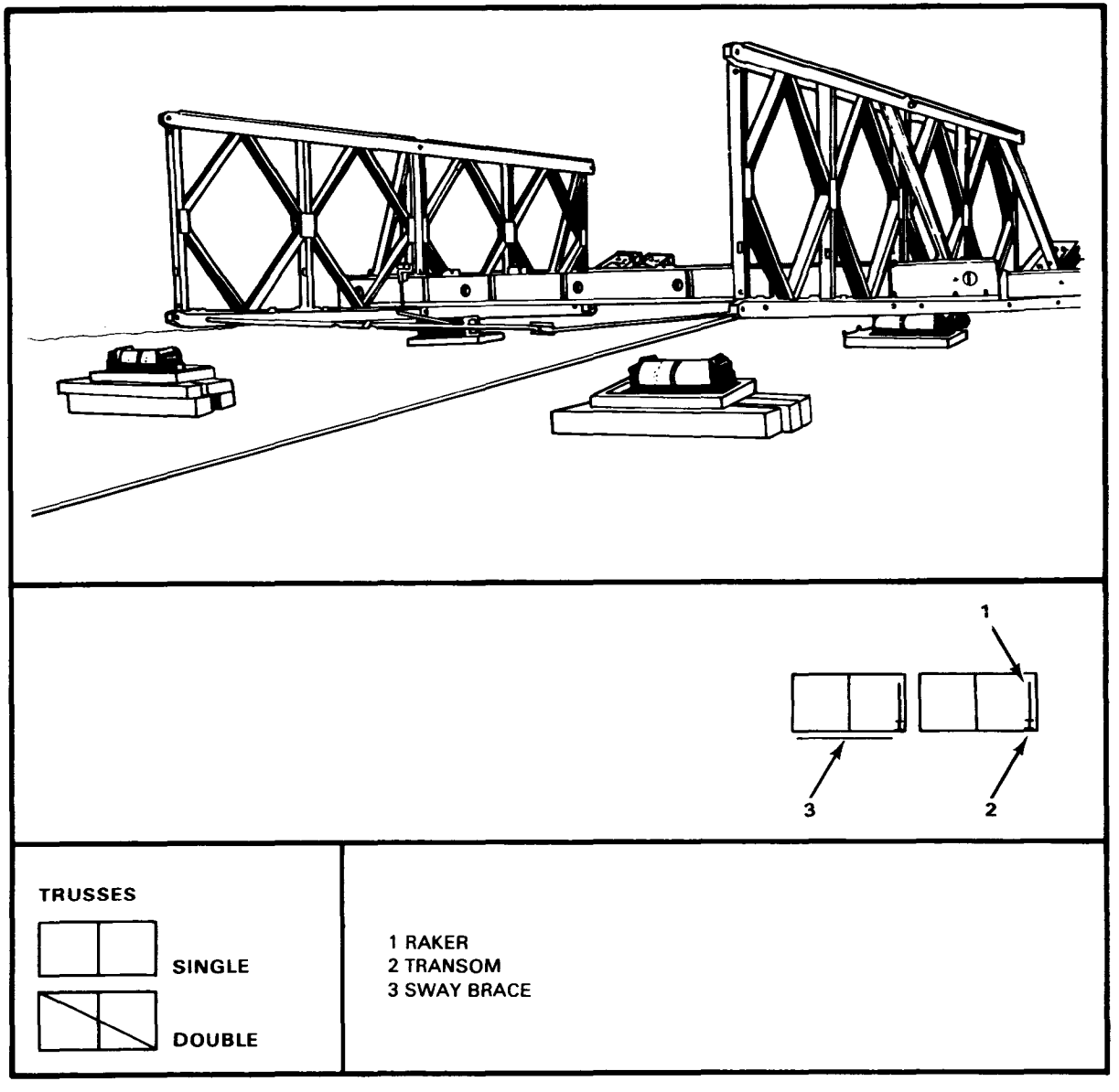


Figure 6-3 ***Launching nose, second bay connected to initial bay***

Notes

Notes

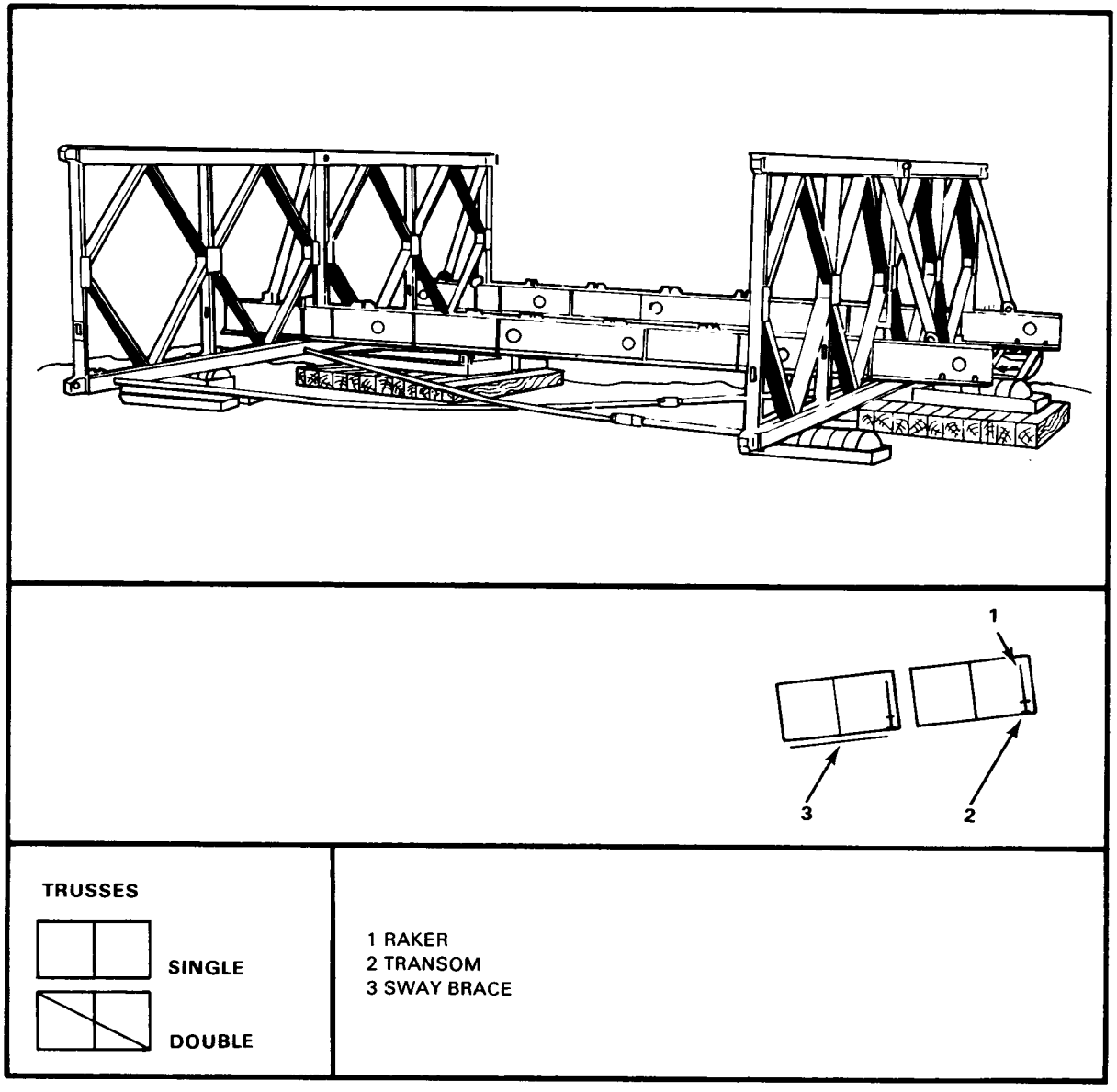


Figure 6-4 ***Two assembled bays of launching nose mounted on rocking rollers***

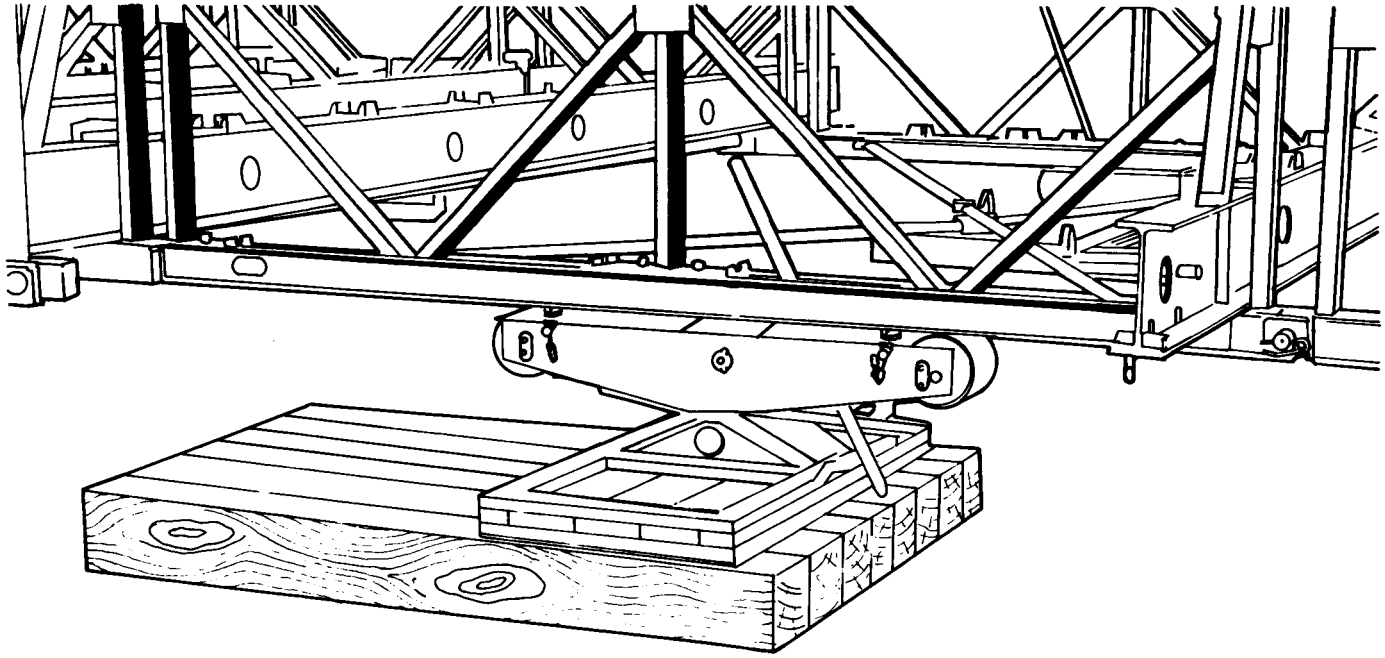


Figure 6-5 ***Front of launching nose with steel picket inserted in rollers to prevent movement***

Notes

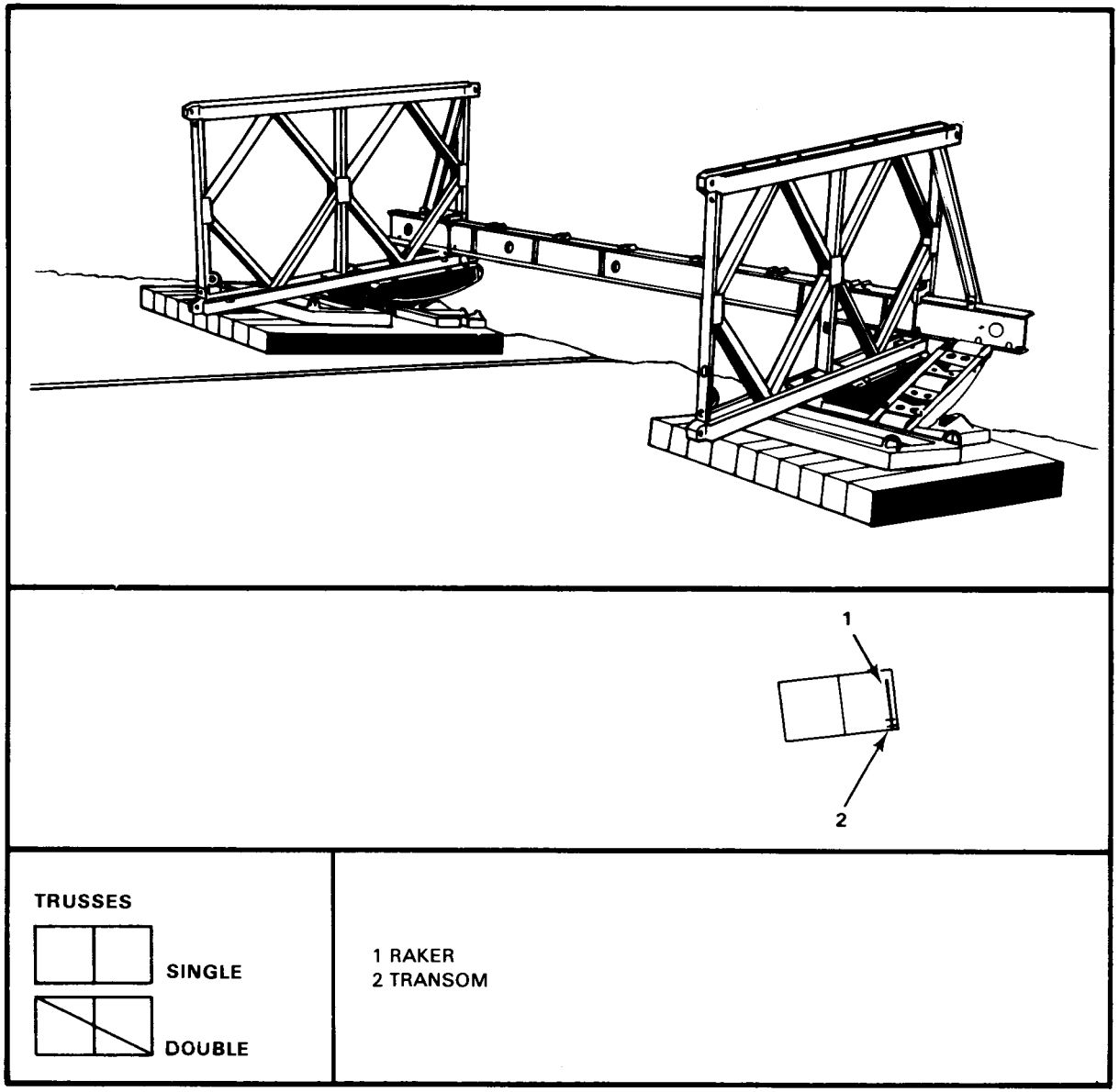


Figure 6-6 ***Alternative method for assembling launching nose when rocking rollers are on low cribbing***

ASSEMBLY OF DOUBLE-SINGLE BRIDGE

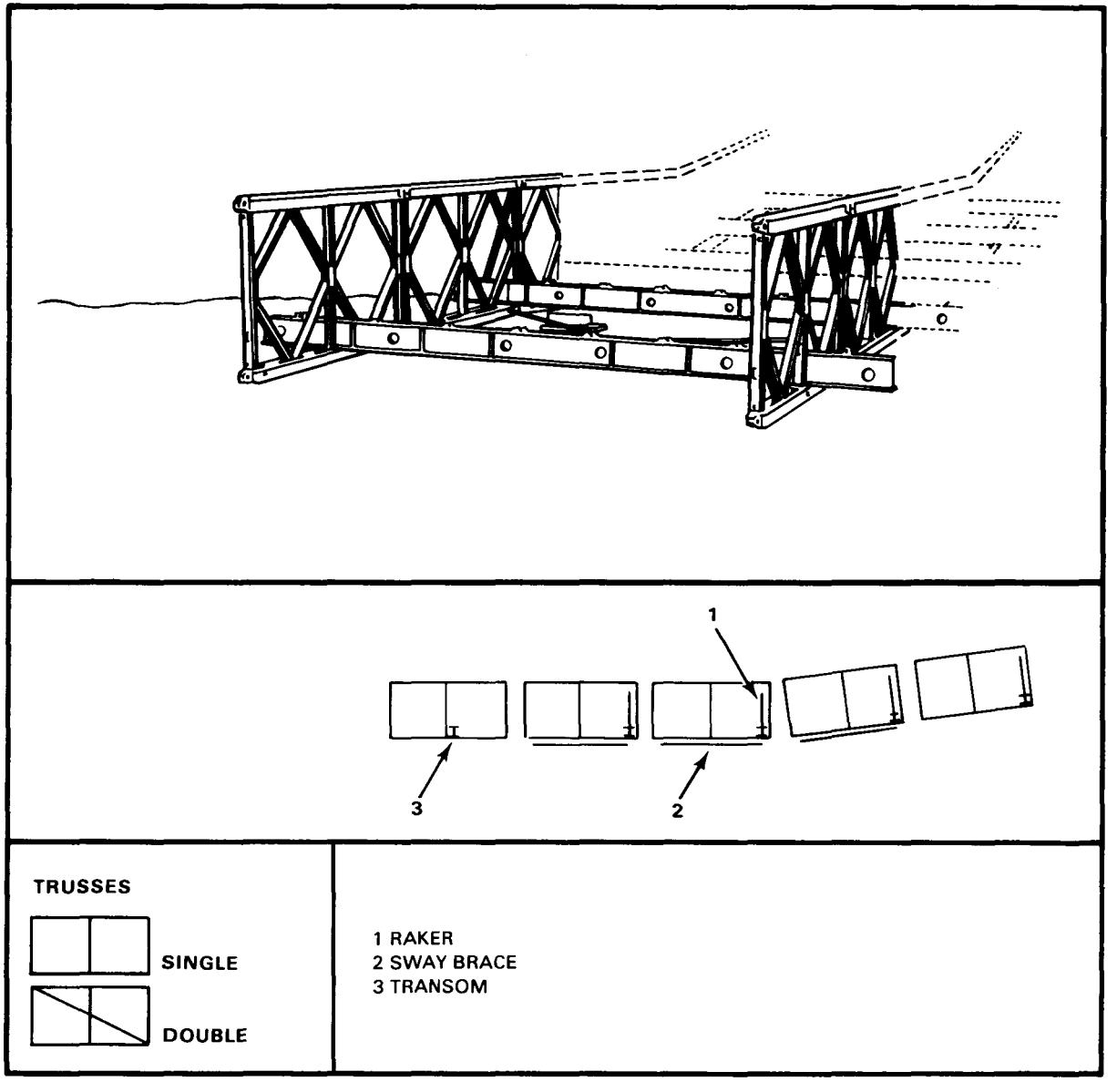


Figure 6-7 ***First bay, DS, assembly—single-truss panels connected to launching nose***

FIRST BAY OF BRIDGE

When assembly of the nose is completed, assemble the first bay of the bridge as follows:

1 Connect first two panels of inner truss with last bay of nose (Figure 6-7). Insert panel pins with points outward and grooves in heads of pins horizontal. Place transom roller on top of the lower panel chord at the transom location. Hook the bottom angle lug of the roller over the near side of the top flange on the chord to hold the roller assembly in position. Lift the head of the transom onto the roller and shove it halfway across bridge width, at which point two soldiers should guide it to its seat on the panel chord. Then raise the near end of the transom enough to permit removal of the roller. Place the first transom in front of the middle vertical and clamp loosely with transom clamps. Then move the transom roller to each succeeding transom point.

2 Add panels of outer truss in first bay and hold in place with transom clamps (Figure 6-8, page 72).

3 Insert second transom in front of rear vertical and third transom behind front vertical. Clamp loosely. Fix rakers to second transom and panel (Figure 6-9, page 73). Then position sway braces with short ends pinned to same side of bridge so both turnbuckles are under one stringer. All sway braces, transom clamps, bracing frames, rakers, and tie plates in one bay should be left loose until all parts

except stringers and decking are fitted for the next bay being assembled.

4 Add second bay of panels (Figure 6-10, page 74). Place outer truss with panel pins pointing inward and inner truss with panel pins pointing outward.

5 Place a chess on top of transom behind front vertical in first bay and position stringers for first bay. Leave stringer over sway-brace turnbuckles on edge until sway braces have been tightened (Figure 6-11, page 75). After bridge has been launched and end-post transom is inserted, the chess holding up the stringers and decking in the first bay can be pushed clear with crowbars, and decking will drop into position.

6 Position panels of third bay. As panels of the third bay are being placed, insert transoms in second bay, one in front of middle vertical and one in front of rear vertical (Figure 6-12, page 76).

7 After transoms are in position in second bay, fix sway braces, rakers, and bracing frames loosely (Figure 6-13, page 77). Rakers are installed only on the transoms at the end verticals.

8 Tighten bracing in first bay, and deck first bay (Figure 6-14, page 78).

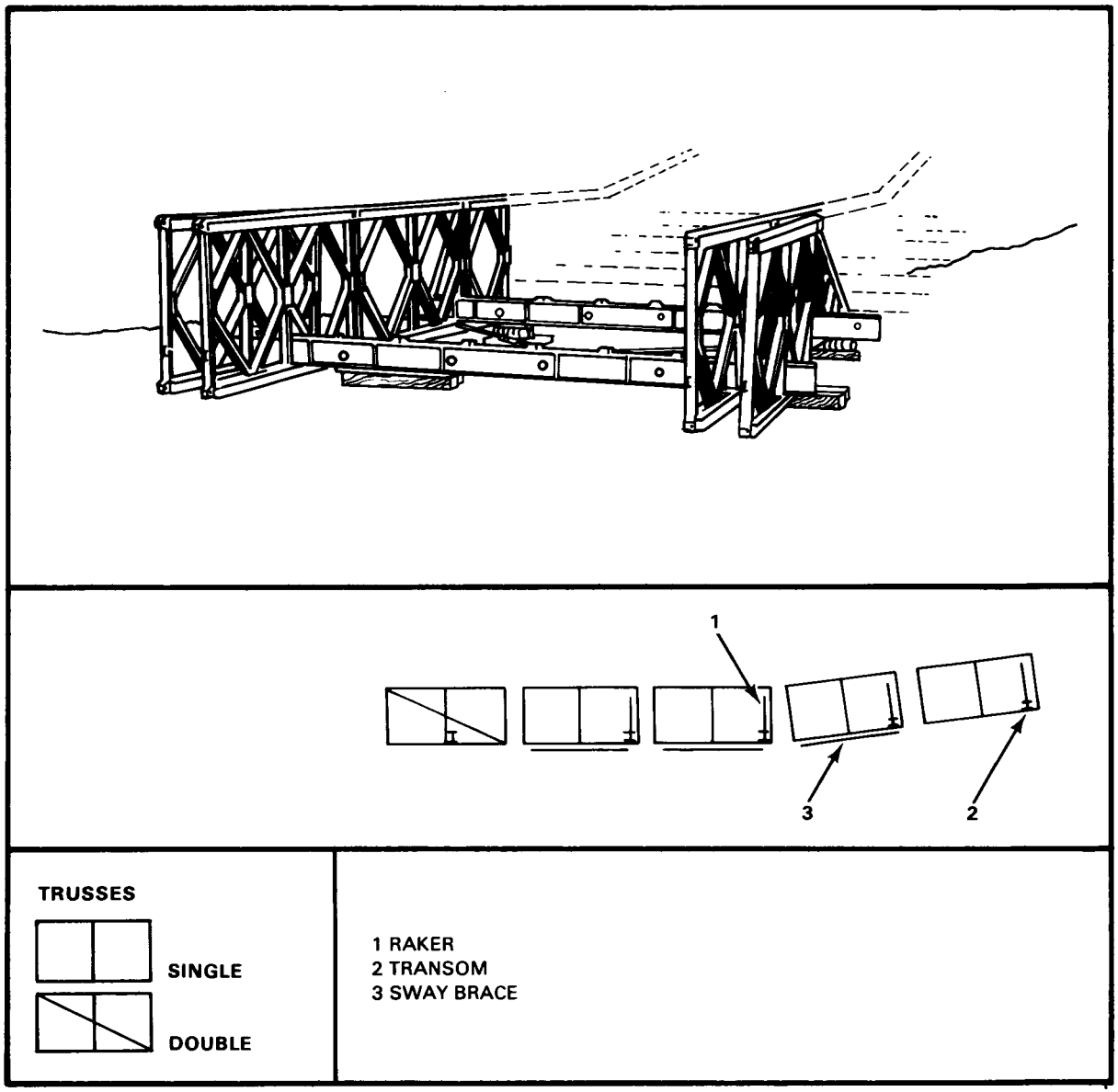


Figure 6-8 ***First bay, DS, assembly—outer-truss panels added to first bay***

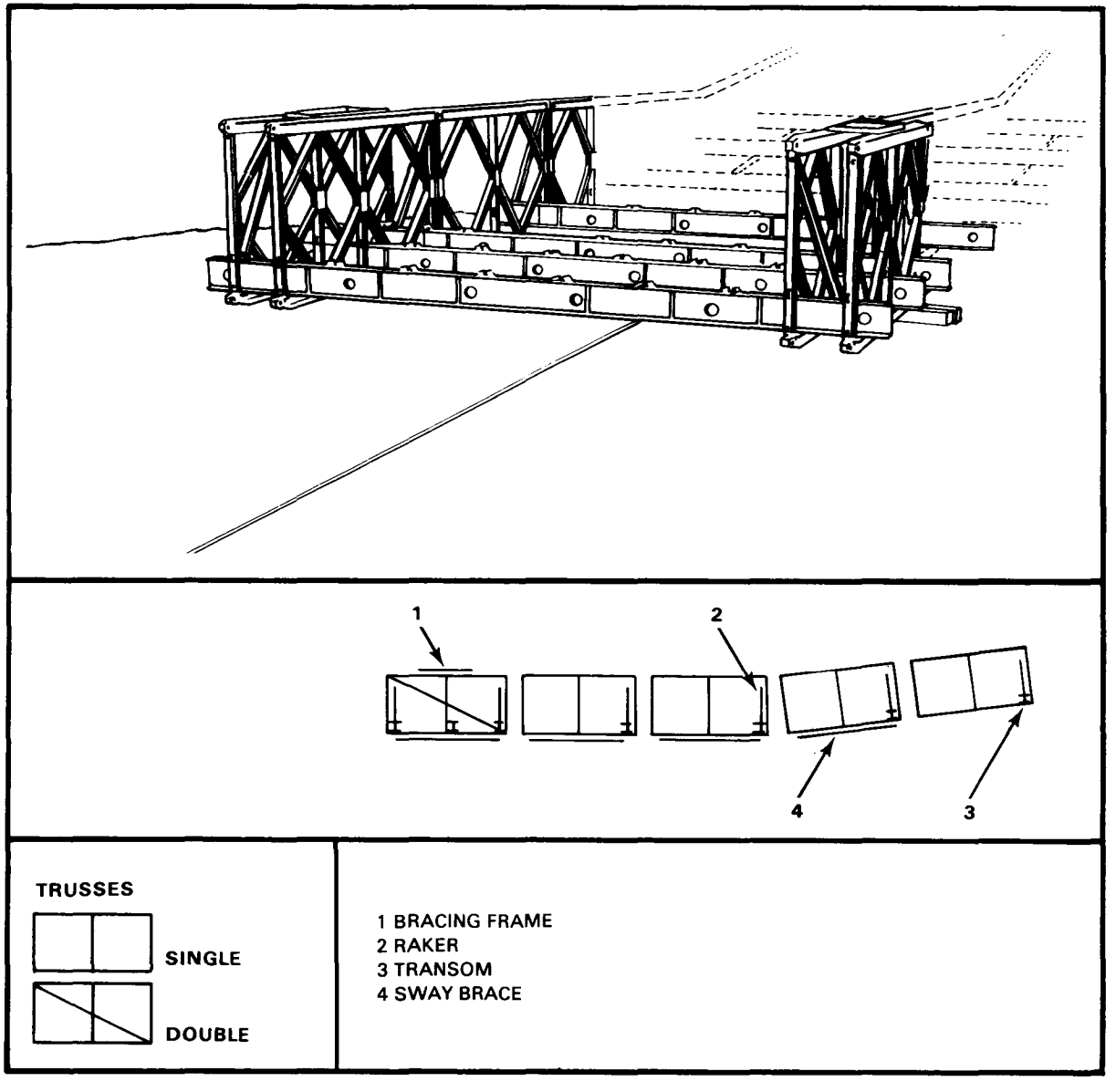


Figure 6-9 ***First bay, DS, assembly—second and third transoms and sway bracing added***

REMAINDER OF BRIDGE

Assemble the remainder of the bridge as follows:

1 Position stringers in second bay and leave stringer over sway-brace turnbuckles on edge until sway braces have been tightened (Figure 6-15, page 79).

2 Add fourth bay of panels and at same time insert transoms in third bay (Figure 6-16, page 80).

3 Add bracing in third bay. Tighten bracing in second bay, and deck second bay (Figure 6-17, page 81).

The sequence is complete. Use the same sequence for the rest of the bridge. Do all jobs at the same time; the sequence is used to prevent crowding of assembly and carrying parties.

Normally, footwalks are not used. However, when time, troops, and materials are available, footwalks can be assembled. Footwalks should be assembled before launching because it is awkward to place bearers and footwalks after bridge is in place. Attach bearers to all transoms. They fit over and under special lugs welded to the transom. Position footwalks by lugs on bearers. Insert footwalk posts in sockets at the ends of bearers and thread hand ropes through the eyes of the posts. Figure 6-18 (page 82) shows the completed footwalk.

Notes

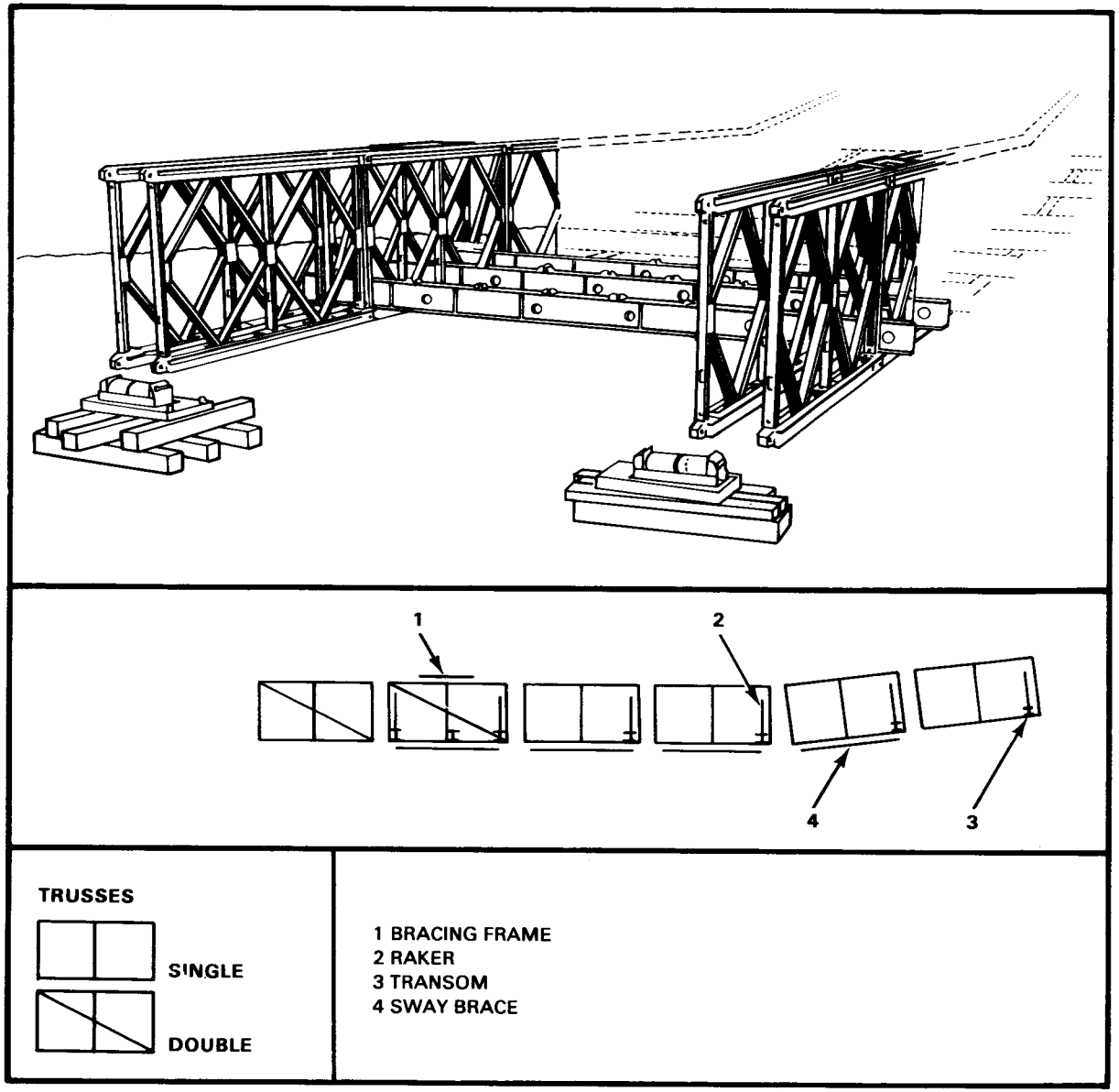


Figure 6-10 ***First bay, DS, assembly—second bay of panels added***

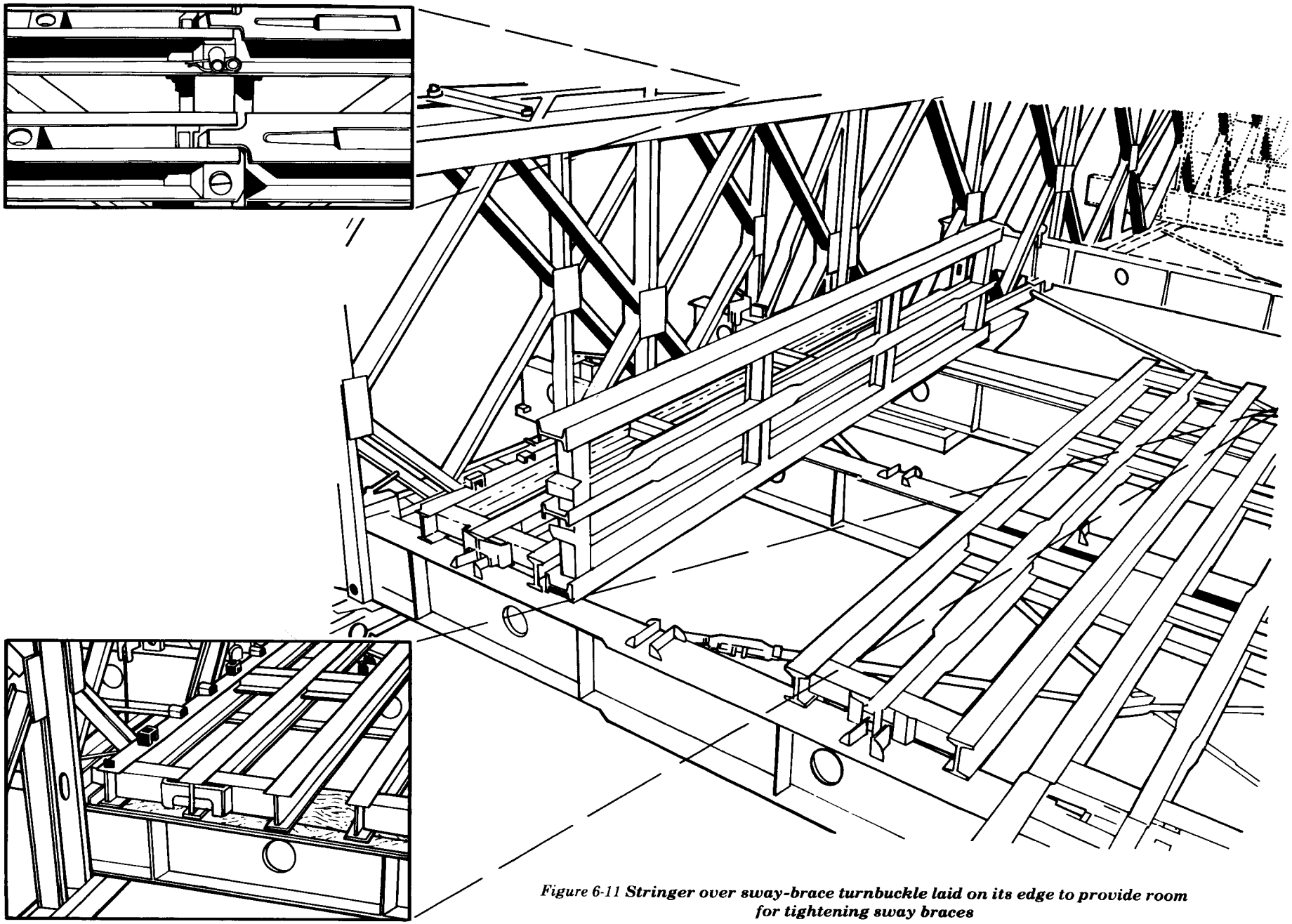


Figure 6-11 ***Stringer over sway-brace turnbuckle laid on its edge to provide room for tightening sway braces***

Notes

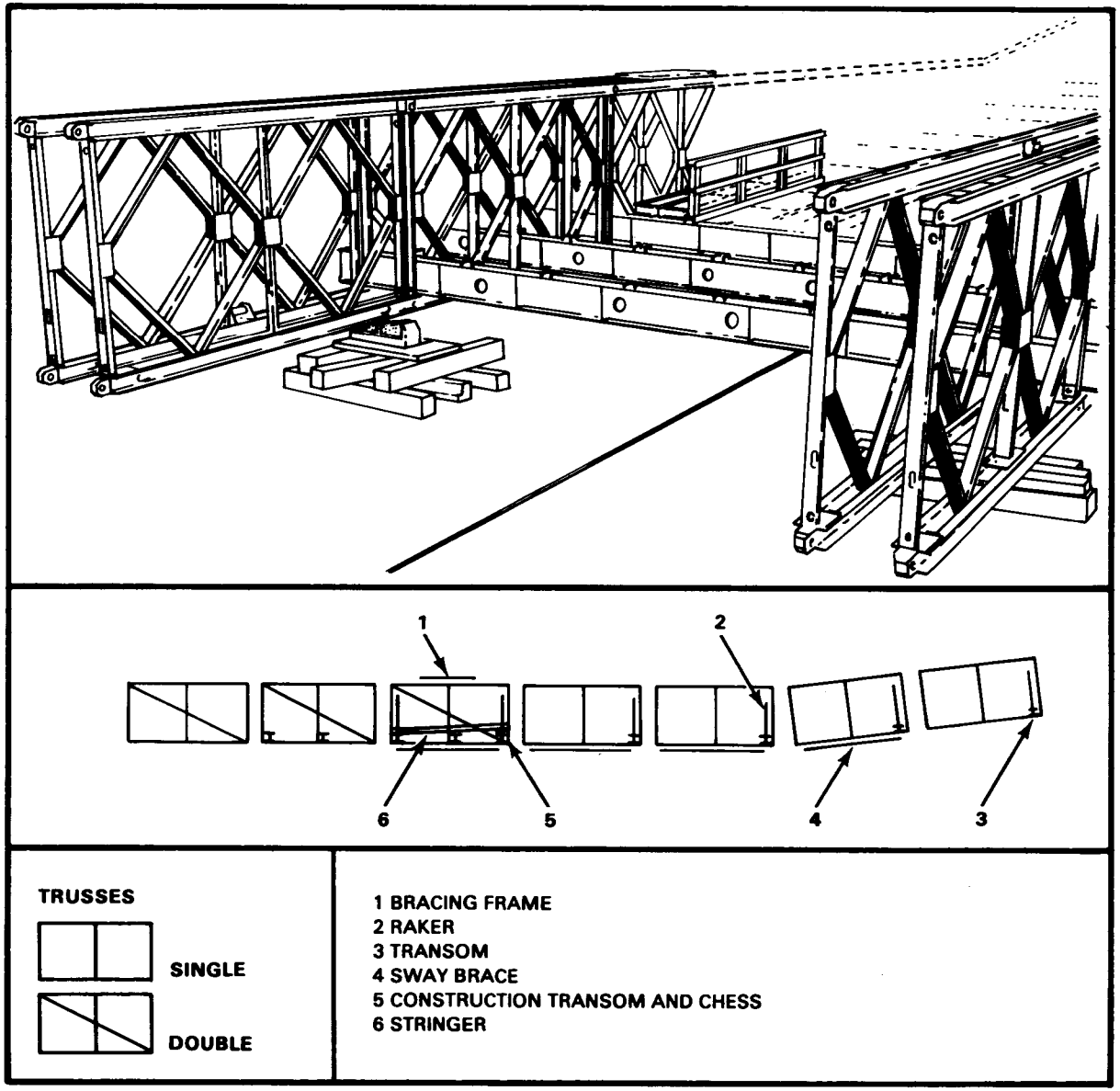


Figure 6-12 ***First bay, DS, assembly—third bay of panels and second-bay transoms added***

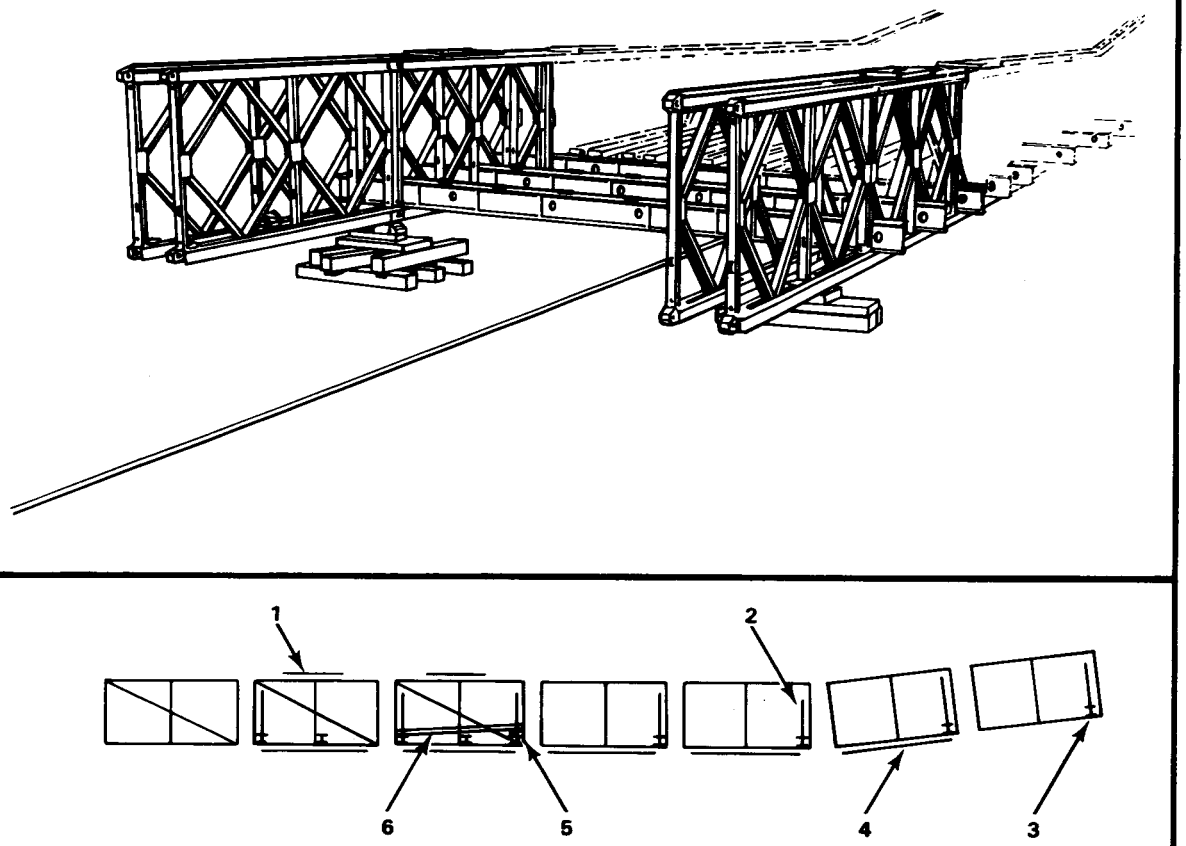


Figure 6-13 ***First bay, DS, assembly—sway braces, rakers, and bracing frames added in second bay***

Notes

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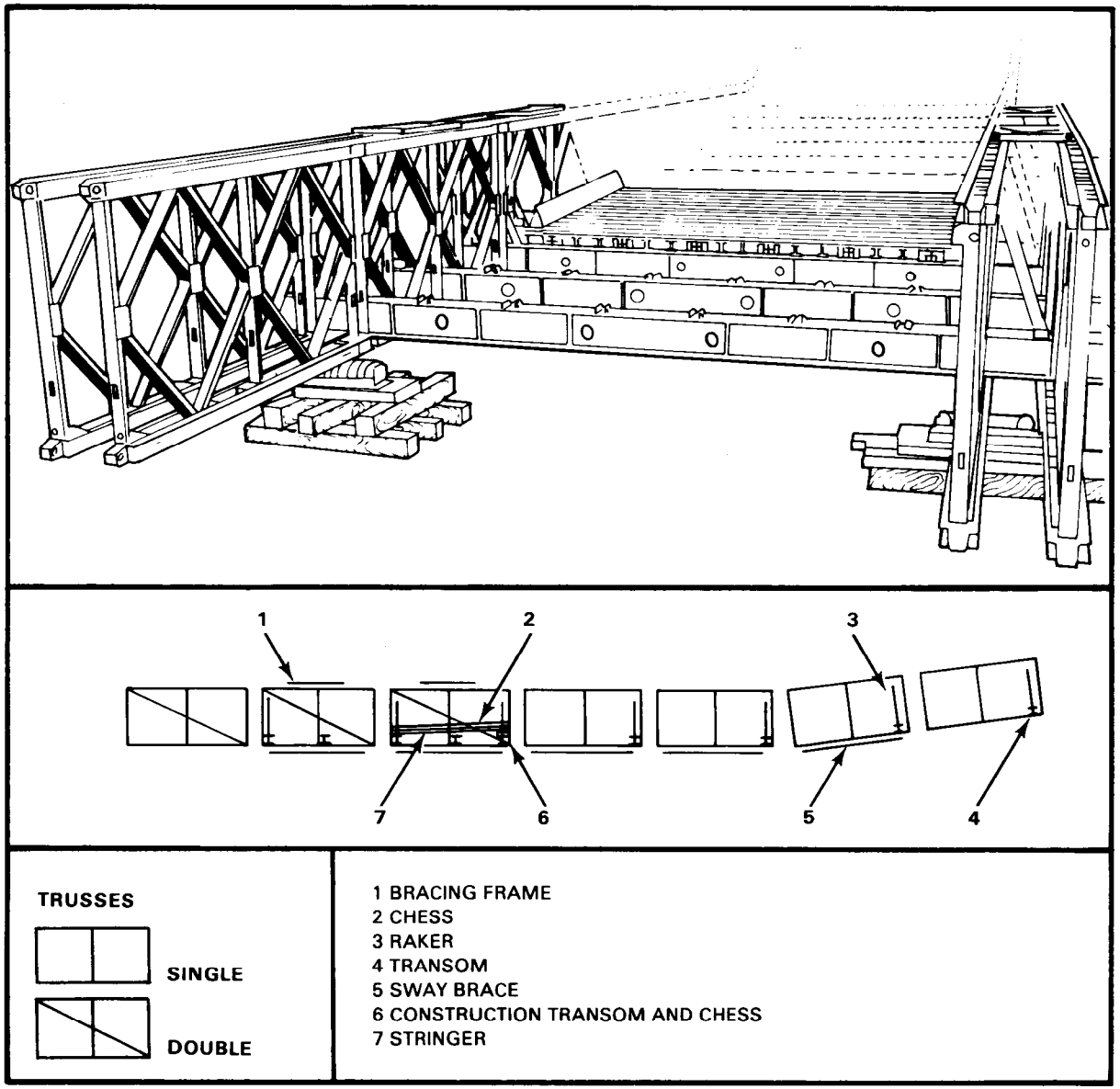

Figure 6-14 ***First bay, DS, assembly—first-bay braces tightened and bay decked***

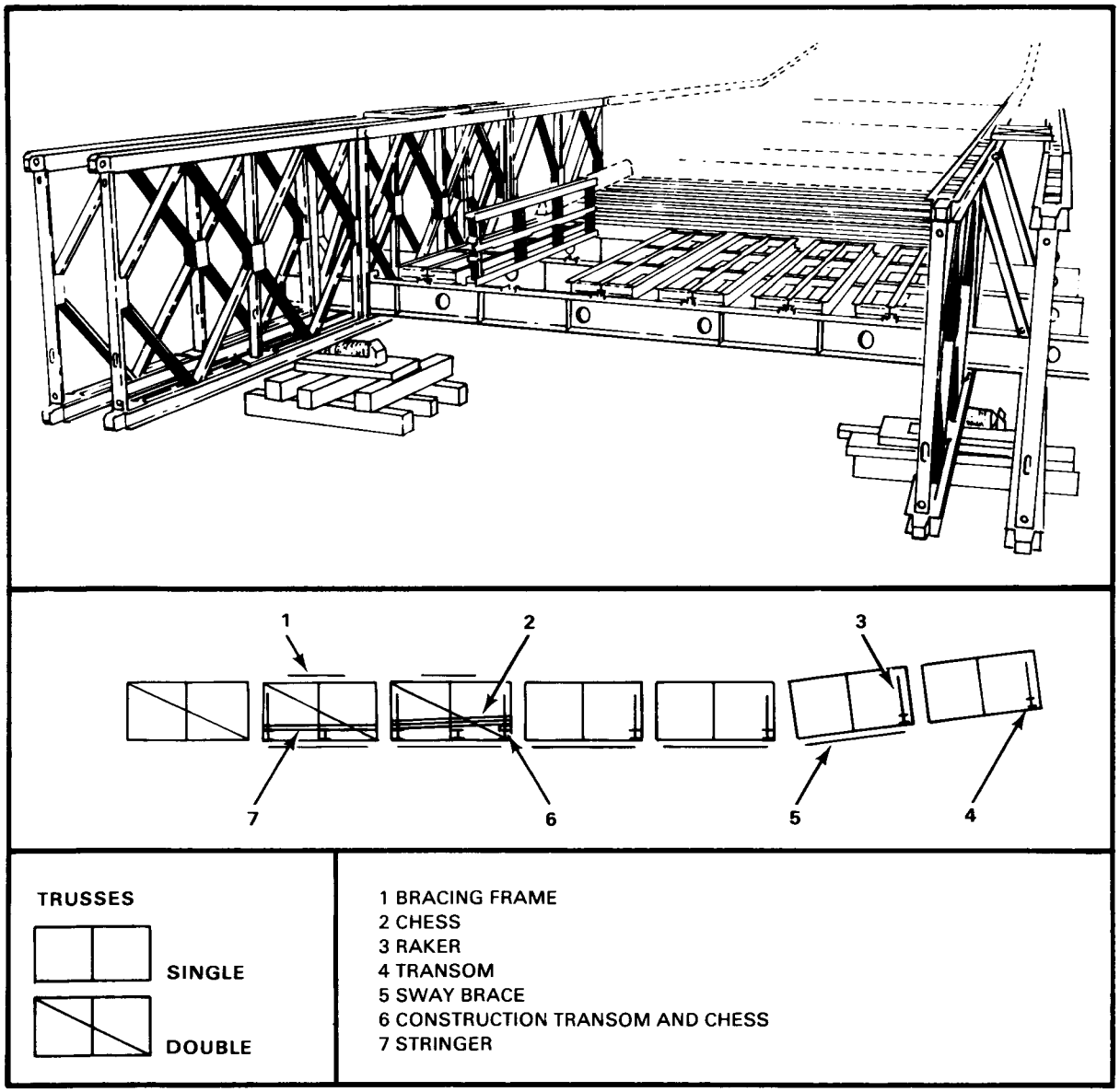

Figure 6-15 ***Assembly of remainder of DS bridge—stringers positioned in second bay***

Notes

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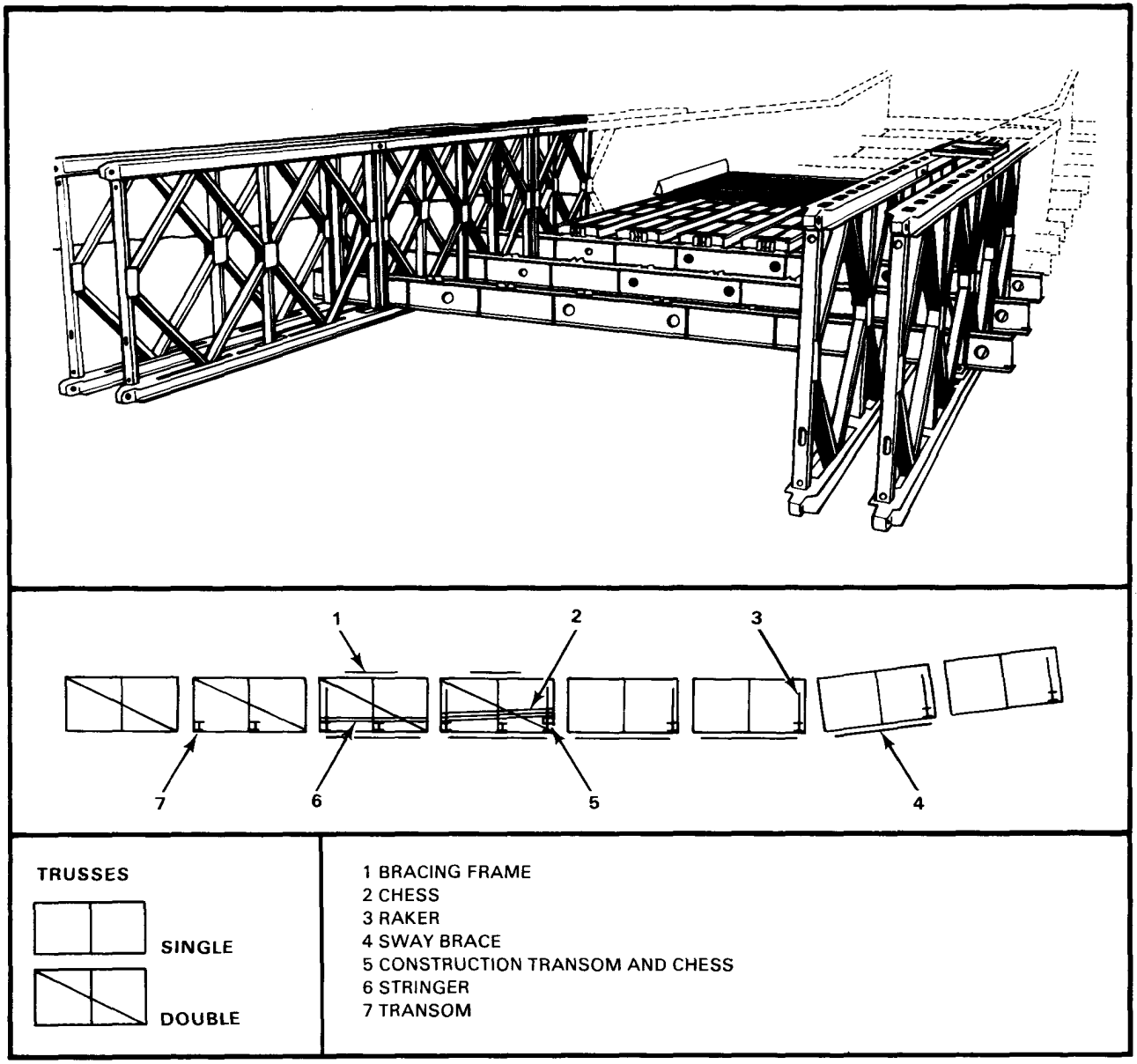


Figure 6-16 ***Assembly of remainder of DS bridge—fourth-bay panels and third-bay transoms added***

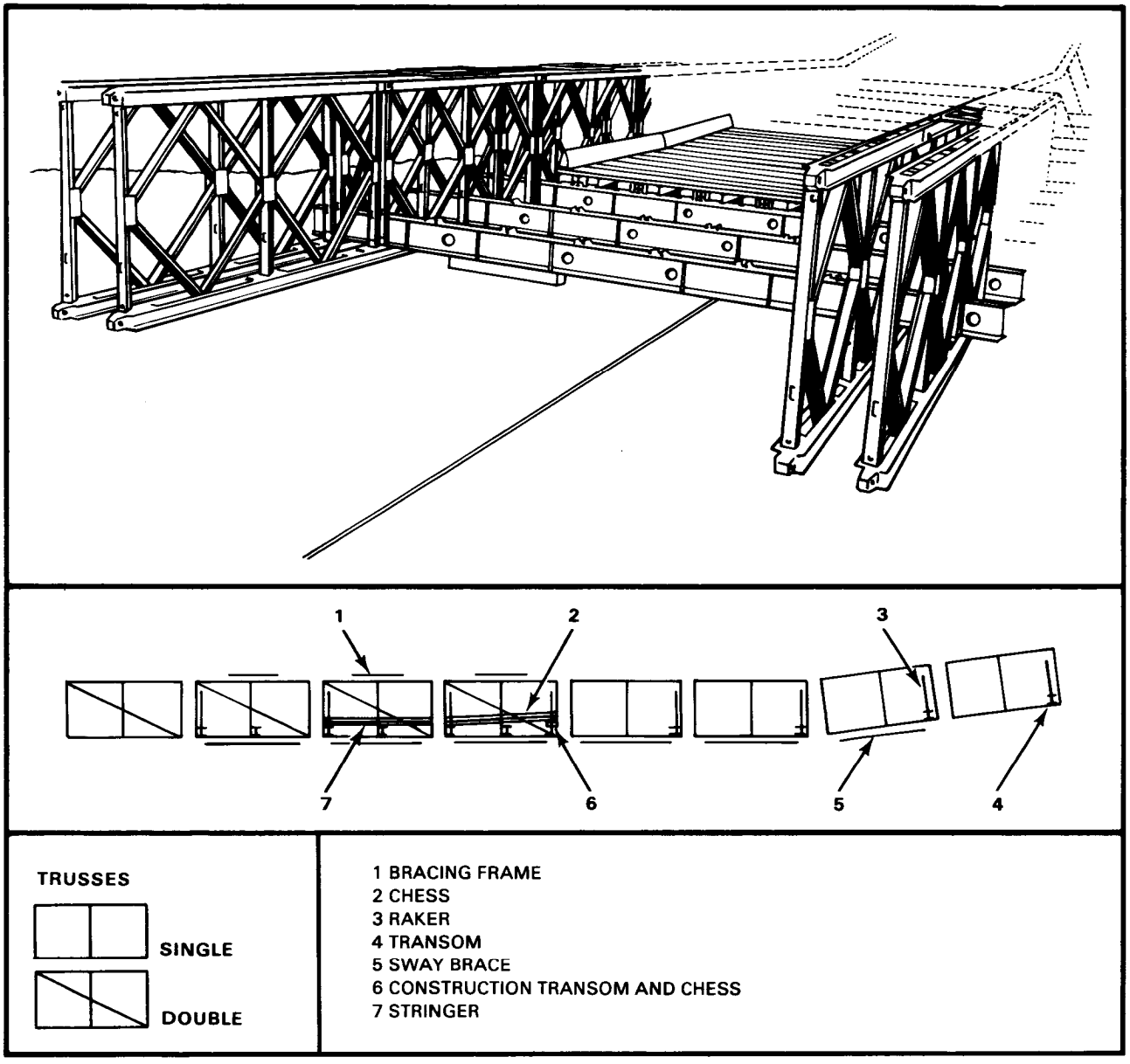
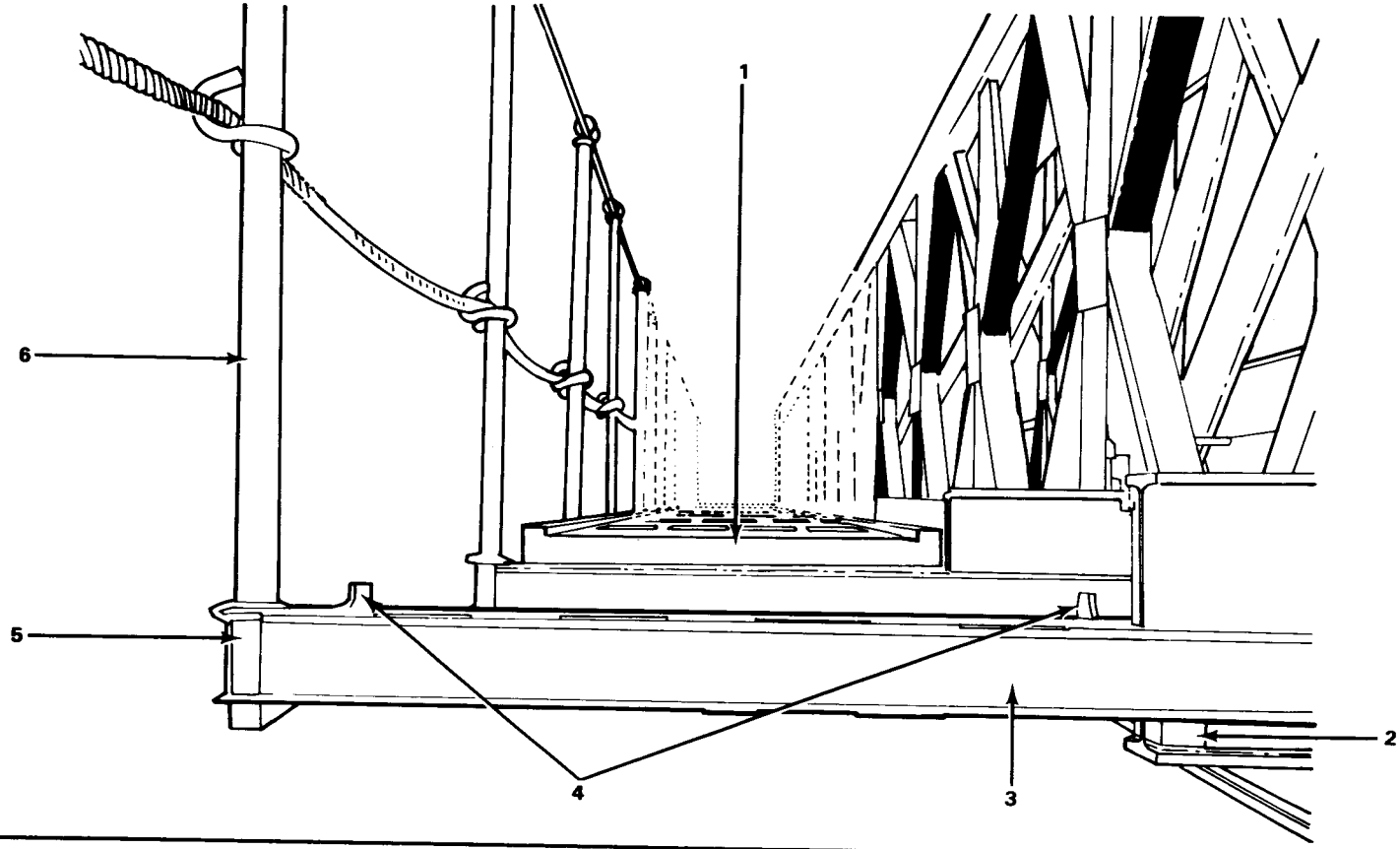


Figure 6-17 ***Assembly of remainder of DS bridge—third-bay bracing added, second-bay bracing tightened, and second bay decked***

Notes



1 FOOTWALK
2 FOOTWALK-BEARER RETAINING LUG
3 FOOTWALK BEARER
4 LUGS TO POSITION FOOTWALK
5 SOCKET FOR FOOTWALK POST
6 FOOTWALK POST

Figure 6-18 ***Footwalk***

ASSEMBLY OF TRIPLE-SINGLE BRIDGE

METHOD OF ASSEMBLY

The method of assembly for the *triple-single* bridge is similar to that for the *double-single* bridge. The assembly of the outer truss in one bay must be delayed, however, so panel pins in the second truss can be inserted. In addition, use short pins in the middle and outer truss end posts because normal length pins will not fit.

FIRST BAY OF BRIDGE

Assemble the first bay of the bridge as follows (Figure 6-19, page 84):

1 Connect first two panels of inner truss with last bay of nose. Insert first transom in front of middle vertical and clamp loosely with transom clamp.

2 Add panels of middle truss in first bay and hold in place with transom clamps.

3 Insert second transom in front of rear vertical. Attach rakers and position bracing frames and sway braces. The construction transom behind front vertical is omitted until the outer truss in the first bay has been positioned.

4 Add middle truss panels in second bay. This panel must be positioned before the outer truss panel in the first bay so panel pins can be inserted.

5 Add outer truss panels to first bay. Position construction transom behind forward verticals in first bay. Add inner truss panels to second bay.

6 Place chess on the construction transom and position stringers in the first bay.

7 Position middle truss panels in third bay. As panels are being placed in the third bay, insert transoms in second bay, one in front of the middle vertical and one in front of the end vertical.

8 Add bracing in second bay. Tighten bracing in first bay, and deck first bay.

REMAINDER OF BRIDGE

Assemble the remainder of the bridge as follows:

1 Position outer truss of second bay. Connect to middle truss with tie plates bolted to top raker holes in forward verticals of panels (Figure 6-21, page 85). Add inner truss of third bay (Figure 6-19). Figures 6-20 (page 85) and 6-21 show the position of panel pins in *triple-single* bridge.

2 Place stringers in second bay. Position middle truss panels in fourth bay, and at same time insert transoms in third bay (Figure 6-19).

3 Add bracing in third bay. Tighten bracing in second ‘bay, and deck second bay (Figure 6-19).

The sequence is complete, and the same sequence is used for the rest of the bridge.

When loads greater than class 70 are to be carried, such as an 80-foot (24.4 meters) *triple-single* bridge, four transoms per bay are required. The procedure for assembling the transoms in the first bridge bay is the same. In addition. a fourth transom is added behind the center vertical. In order to clamp both transoms at the center vertical, the transom held behind the vertical should be clamped to the inside trusses and the other to the outside trusses. In all subsequent bays, the four transoms are placed in regular order, the first behind the front vertical, one in front of the center vertical, one behind it, and one in front of the rear vertical.

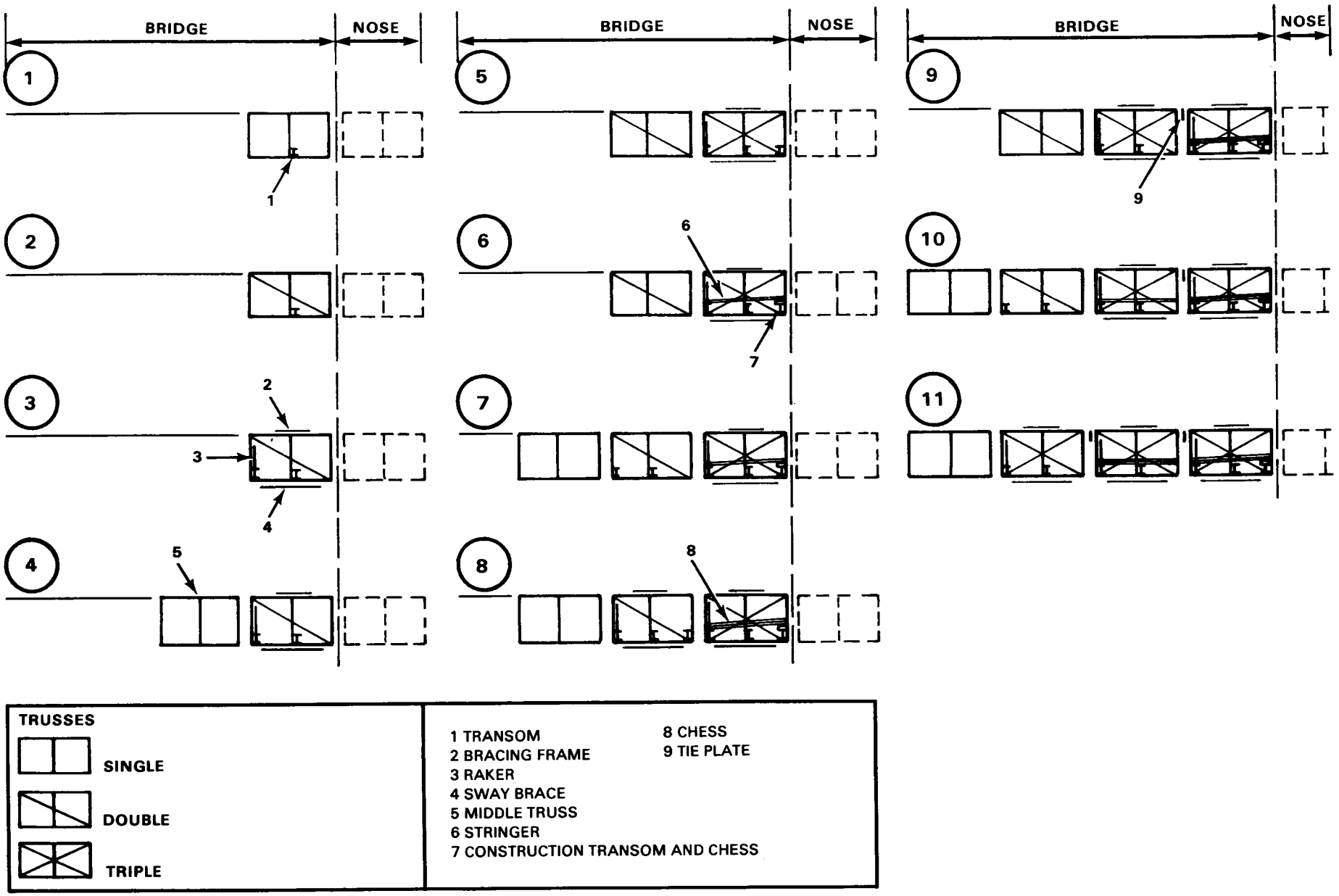


Figure 6-19 ***Assembly of TS bridge***

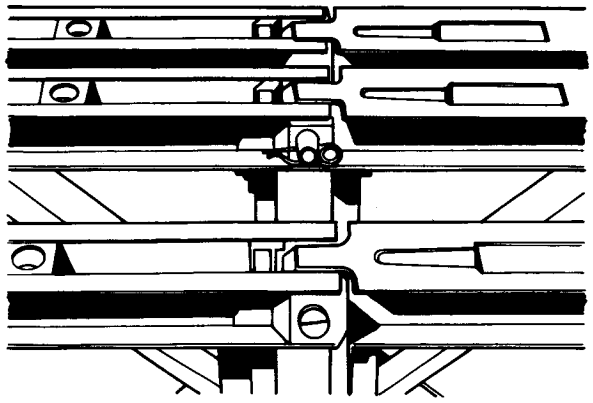


Figure 6-20 ***Position of panel pins in TS bridge—pins in main part of bridge***

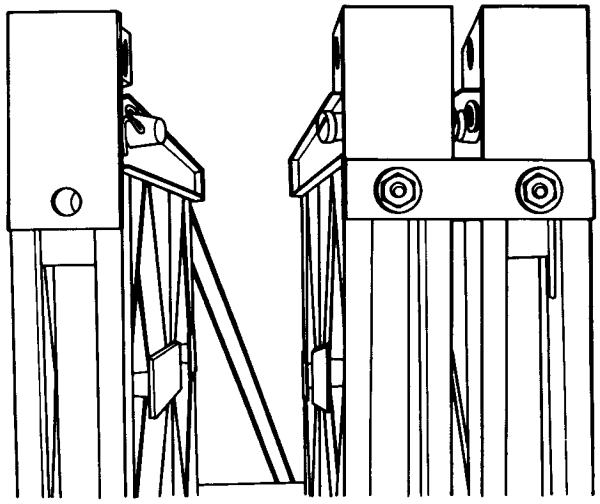


Figure 6-21 ***Tie plates between second and third trusses and short panel pins in end posts in TS bridge***

LAUNCHING, JACKING DOWN, AND RAMPING

USE OF COUNTERWEIGHT

During launching, the entire bridge (including the nose) must be counterbalanced so the structure does not tip into the gap. The counterbalance is normally obtained by adding enough bays of bridge behind the near-shore rocking rollers to act as a counterweight, keeping the balance point between the plain rollers and the rocking rollers. This condition must prevail until the launching nose reaches the rollers on the far bank. The point is illustrated in Tables 6-1 through 6-3 which show the bridge and launching nose just spanning the gap. In this position, the bridge is completely assembled and the balance point is slightly behind the near-shore rocking rollers. As the bridge is pushed across the gap from this position, the balance point passes the rocking rollers. The part of the bridge acting as a counterweight is no longer needed to maintain balance since there is now no danger of it tipping into the gap.

Note: Counterbalance is still needed, however, to avoid excess stress in the launching nose until launching is complete. Dismantling any part of the bridge behind the rocking rollers will throw additional stress on the launching nose and on the part of the bridge which is across the gap. This may result in failure of the nose.

Caution: **The near-bank rocking rollers and the far-bank rocking rollers must carry the entire load after the launching nose reaches the far-bank rocking rollers (Figure 6-22, page 86). The launching nose may fail if the near-bank plain rollers are permitted to carry any load after the nose reaches the far-bank rocking rollers. The rear of the bridge must hang free to act as a counterweight. This is done by cribbing up the near-bank rocking rollers, or removing plain rollers so the rear end of the bridge does not rest on them after the launching nose reaches the far-bank rocking rollers.**

If removal of plain rollers does not provide the required clearance, excavate until the overhang is free of the ground. If the far-bank rocking rollers are placed several inches below the level of the other rollers, the entire weight of the bridge on the near-bank rocking rollers will be offset so that the resulting launching plane will be level or err on the safe side. In addi-

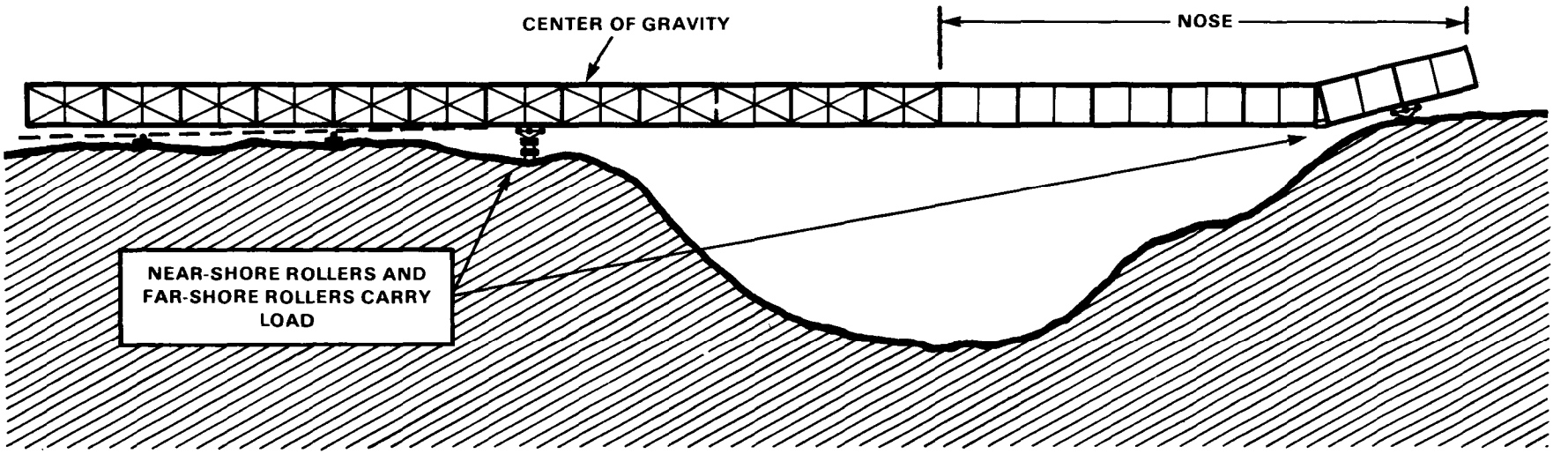


Figure 6-22 ***Position of rollers***

tion, the extra 6-inch (15.2 centimeters) safety allowance in the positioning of the launching-nose links will help prevent an unsupported length of bridge from the far-bank reeking rollers to the first near-bank plain rollers from being clear of the rocking rollers. Once the links have passed over the far-bank rollers, check the launching plane. If too much settlement has occurred on the near bank, remove the plain rollers.

LAUNCHING

After the nose and first bay of the bridge have been completed, proceed with launching as follows:

1 One pair of plain rollers has been placed 25 feet (7.6 meters) behind the near-bank rocking rollers. Additional plain rollers are not required when launching bridges up to 80 feet (24.4 meters) long. Bridges over 80 feet (24.4 meters) long require additional sets of plain rollers spaced at 25-foot (7.6 meters) intervals. Bridges are assembled on the rollers. When necessary, jacks are used to aid insertion of the lower panel pins of panels resting on rollers.

2 Continue assembly of bridge and pushing it out on the rollers (Figure 6-23). When the forward end of the launching nose

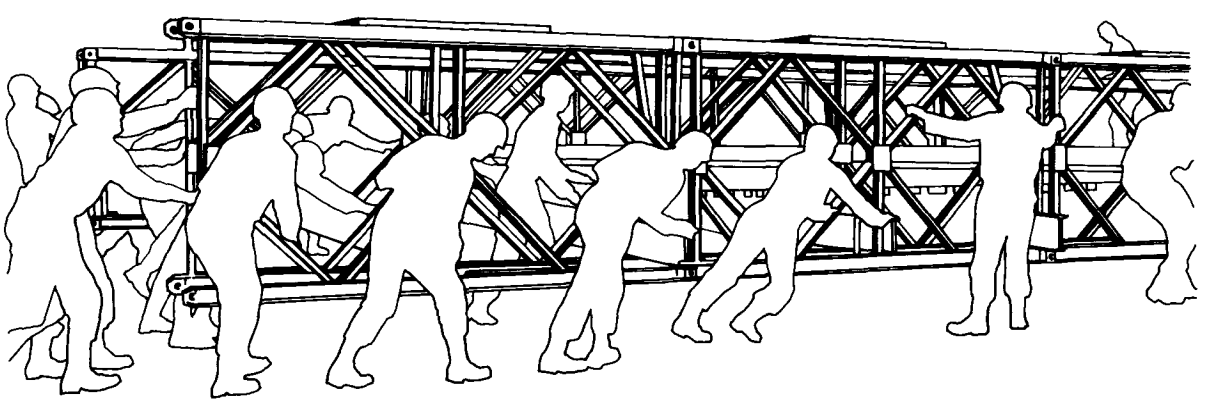


Figure 6-23 ***Pushing bridge over gap***

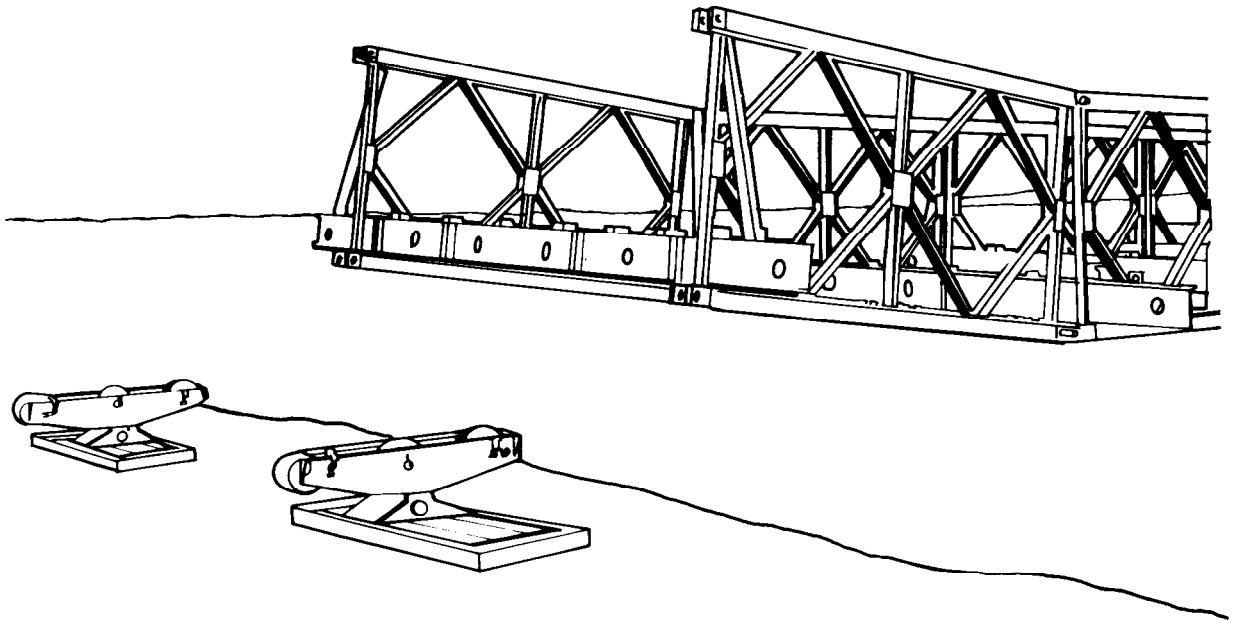


Figure 6-24 ***Launching nose approaching far bank, rocking rollers in place***

reaches the rollers on the far bank (Figure 6-24), a detail guides it onto the rollers (Figure 6-25, page 88) and dismantles it bay by bay.

3 When the end of the bridge proper clears the rollers on the far bank, attach the near-bank end posts. At the same time, attach the far-bank end posts and lay a transom across their steps. The middle and outer truss end posts on the triple-truss bridge are pinned with short panel pins and tied together with tie plates in the raker holes. Pins in middle truss end posts are inserted with points outward and in outer truss with points inward (Figures 6-20 and 6-21). Normal pins and methods of pinning are used on the inner-truss end posts. Remove construction chess behind the front vertical in the first bay so decking drops into place.

Take the following precautions when completing the assembly and launching

- Do not use bent or distorted parts.
- Do not attempt to convert the launching nose into the bridge by adding parts to it.
- In launching the bridge over rollers, keep the center of gravity behind the rocking rollers until the launching nose reaches the far bank. Thereafter, do not dismantle the bridge behind the near-bank rocking rollers or remove the counterweight until all of the launching nose has cleared the far-bank rocking rollers.
- After the launching nose passes over the far-bank rocking rollers, always make certain the weight of the bridge is carried only by the near-and the far-bank rocking rollers.

JACKING DOWN

After the end posts and end transom have been installed, proceed with jacking down as follows:

1 Place jack shoe in baseplate and jacks on shoes with toes of jacks under steps of end posts (Figure 6-26, page 88). Only enough room is present to work four jacks at one end of the bridge. More jacks may be placed under a transom only when held by end posts. To prevent failure of jacks, use them in unison so the load is distributed evenly between them.

Note: Pitch of teeth may vary in jacks of different manufacture. Jacks used together must always have the same pitch. Check jacks to ensure that they have the same manufacturer's name.

2 Jack up the ends of the bridge successively and remove the rocking rollers. Place bearings on baseplate as shown in Figure 5-9.

3 Lower bridge in stages (Figure 6-27, page 89). Place cribbing under the bottom chord of the trusses to catch the bridge if it slips

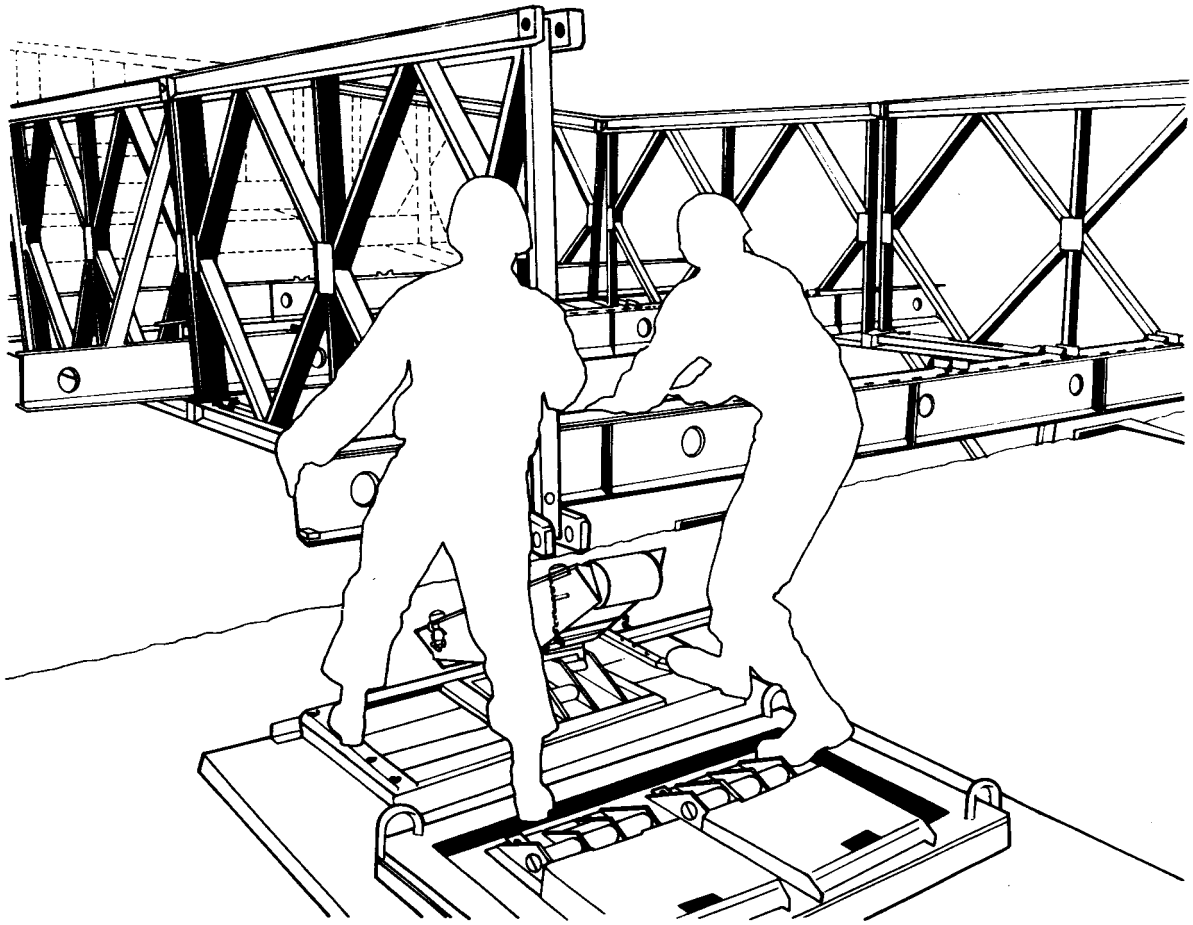


Figure 6-25 ***Guiding launching nose onto rocking rollers***

off the jacks. It does not matter which end of the bridge is lowered first, but the jacks must be operated in unison.

Note: Jacks must be operated on only one end of the bridge at a time.

RAMPING

Refer to already determined design in Chapter 4 for installing cribbing and supports (Figure 6-28). Position ramps and add decking (Figure 6-29, page 90). Brace approach to ramps, and bridge is complete.

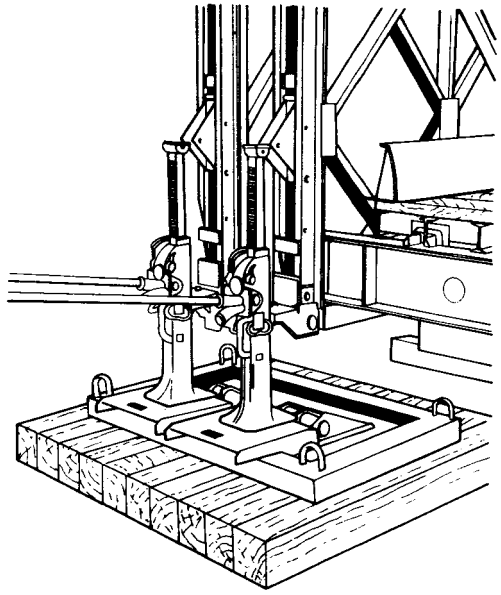


Figure 6-26 ***View of jacking operation showing the placement of the jack, jack shoe, and bearing***

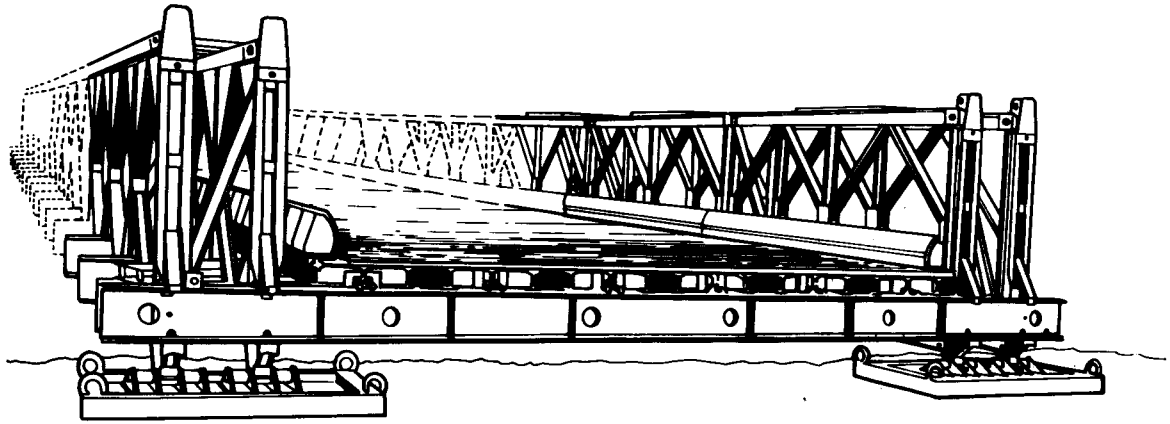


Figure 6-27 ***End of bridge jacked down on bearings***

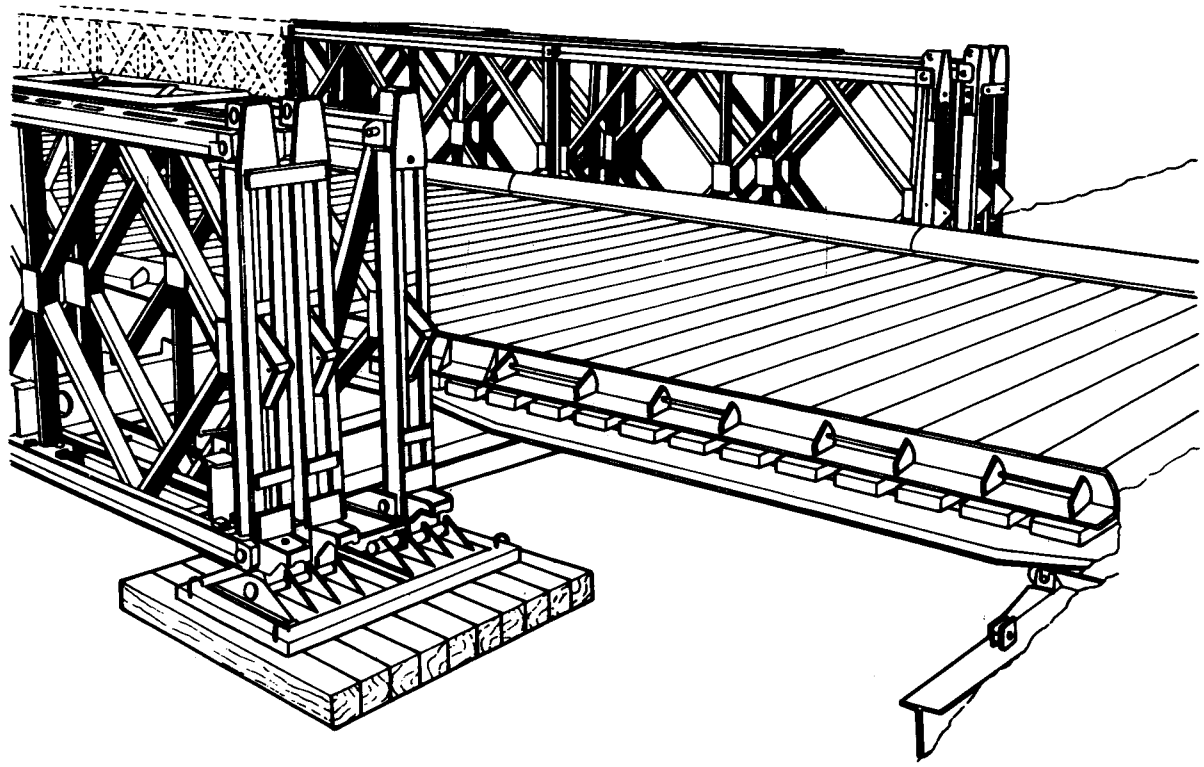


Figure 6-28 ***Single-bay ramp completely decked***

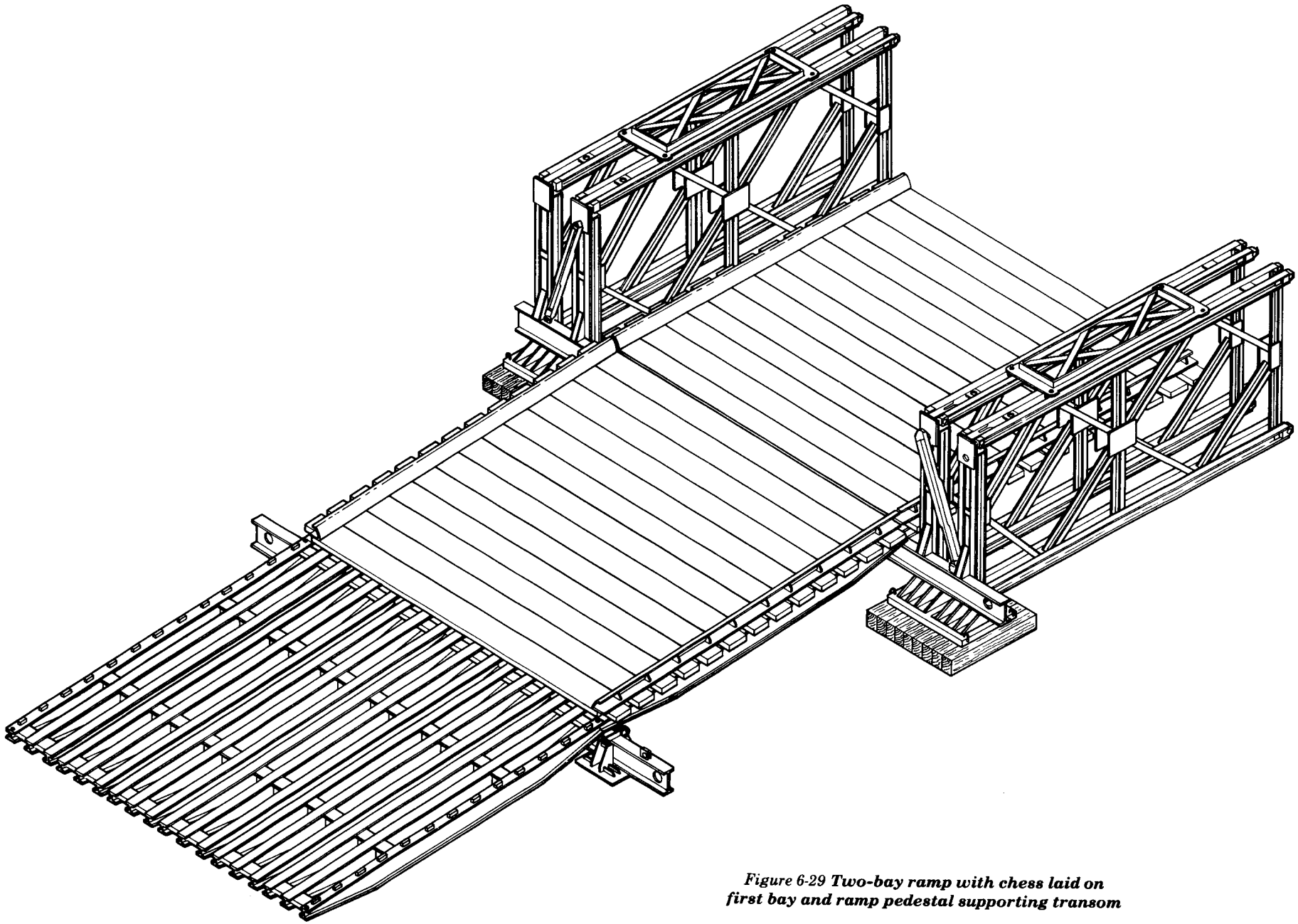


Figure 6-29 ***Two-bay ramp with chess laid on first bay and ramp pedestal supporting transom***

REINFORCING BRIDGE AND CONVERTING BRIDGE

PROCEDURE

The class of existing single- and double-truss bridges can be increased by adding extra trusses. Construction starts from the center of the bridge, and panels are added toward each end. Panel levers are used to aid in positioning the extra panels (Figure 6-30).

For all assemblies over class 70, the deck system must be reinforced by increasing the number of transoms per bay from two to four and by adding a 3-inch (7.6 centimeters) longitudinal wear tread. These transoms can be threaded a bay at a time from inside the bridge.

CONVERTING SINGLE-SINGLE TO DOUBLE-SINGLE

To convert a *single-single* bridge to a *double-single* bridge, proceed as follows:

1 Remove footwalk (if any).

2 Position first panel at center of bridge.

3 Lower panel over side with chain or rope slings at ends of panel and position with levers (Figure 6-30).

4 Insert transom clamps and tighten. Tightening transom clamps helps reduce effect of sag.

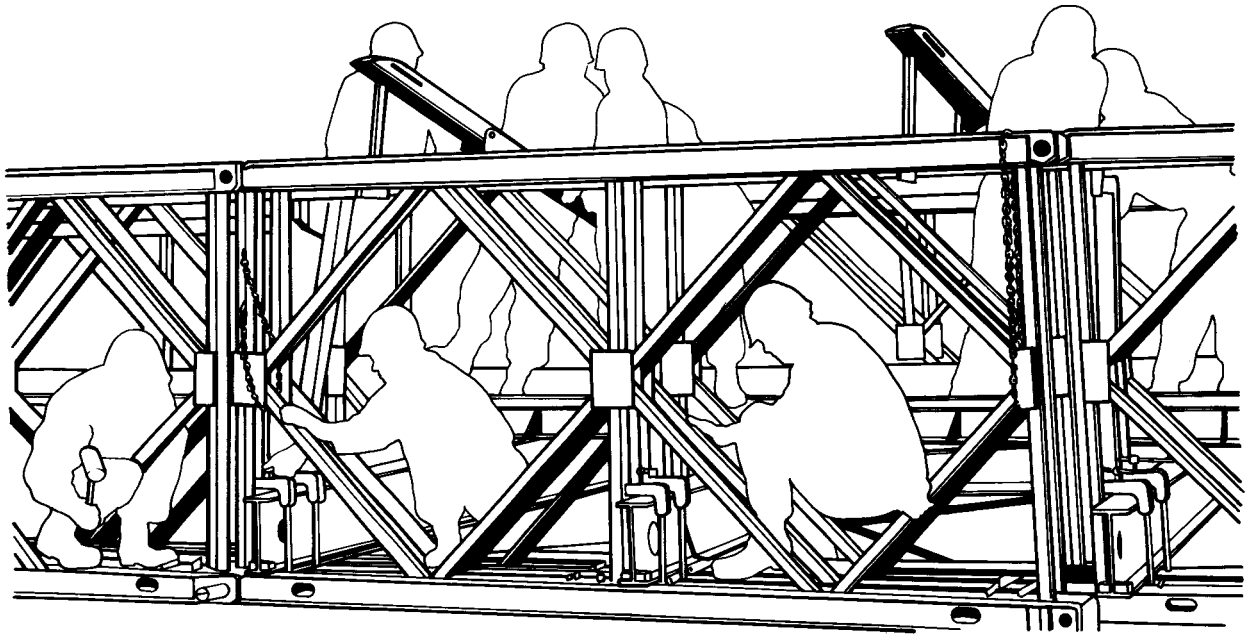


Figure 6-30 ***Inserting panel of outer truss***

5 Position second panel, insert transom clamps, and tighten. Insert panel pins (point inward) first in bottom and then in top of panel.

6 Connect outer truss to inner truss with bracing frames bolted to top chord. Continue adding panels toward each end of bridge.

7 Jack bridge off bearings (ramps need not be removed) and install end posts.

Caution: **At the end of bridge where the transom is in the end post, panel and post must be added as one unit.**

8 Position bearings for double-truss assembly, jack bridge down on bearings, and replace footwalks (if any).

9 Check to ensure that the existing grillage is strong enough to carry the reinforced class.

Figure 6-31 (page 92) shows a complete *double-single* bridge with footwalk.

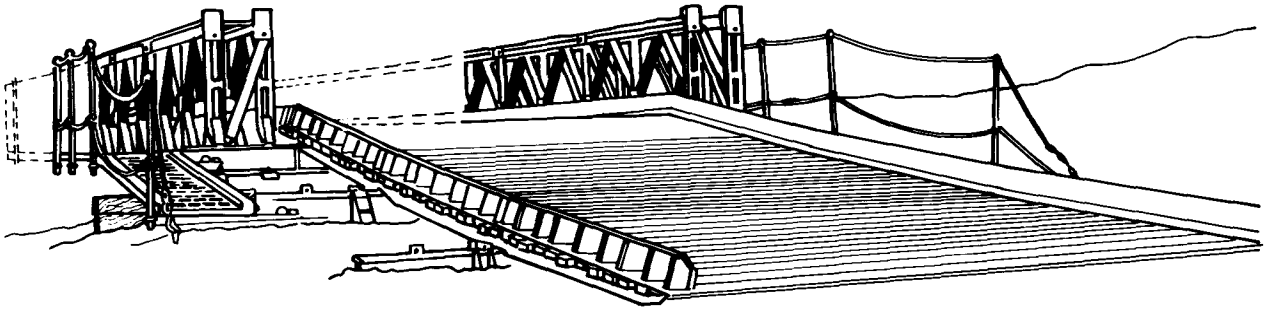


Figure 6-31 ***DS bridge with footwalk***

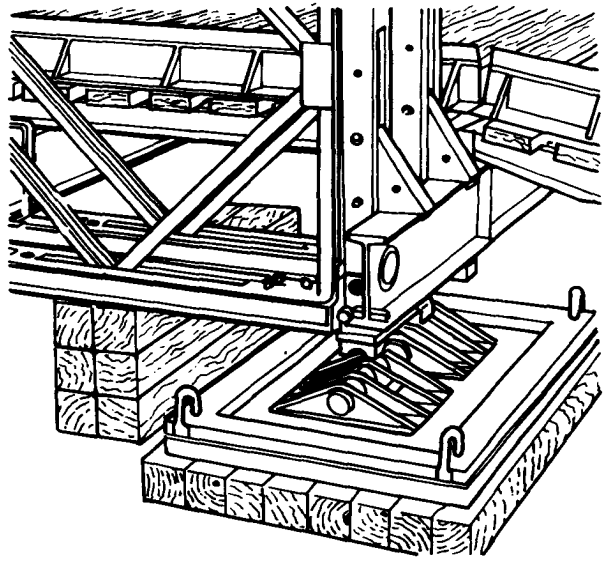


Figure 6-32 ***Double-truss bridge jacked up and cribbed at end where transom is in end post before insertion of outer truss***

CONVERTING DOUBLE-SINGLE TO TRIPLE-SINGLE

To convert *double-single* bridge to a *triple-single* bridge, proceed as follows:

1 Use same procedure as for converting *single-single* to *double-single* bridge, through insertion of panel pins in top and bottom of panel.

2 Connect outer truss to middle truss with tie plates bolted to top raker holes in the same upright of successive panels (Figure 6-20). Continue adding panels toward each end of bridge.

3 Jack bridge off bearing (ramps need not be removed) and crib under first and second truss (Figure 6-32).

Note: Cribbing must not extend out beyond second truss.

4 Install end panel and end post by raising into position with levers (Figure 6-33).

Caution: **At the end of the bridge where the transom is in the end post, the panel and post must be added as one unit.**

5 Insert panel pins, point inward, slot horizontal. Add tie plates.

6 Shift bearings for double-truss assembly to bearings for triple-truss assembly. Jack down bridge on bearings (Figure 6-34).

7 Replace footwalk if needed.

8 Check to ensure that the existing grillage is strong enough to carry the reinforced class.

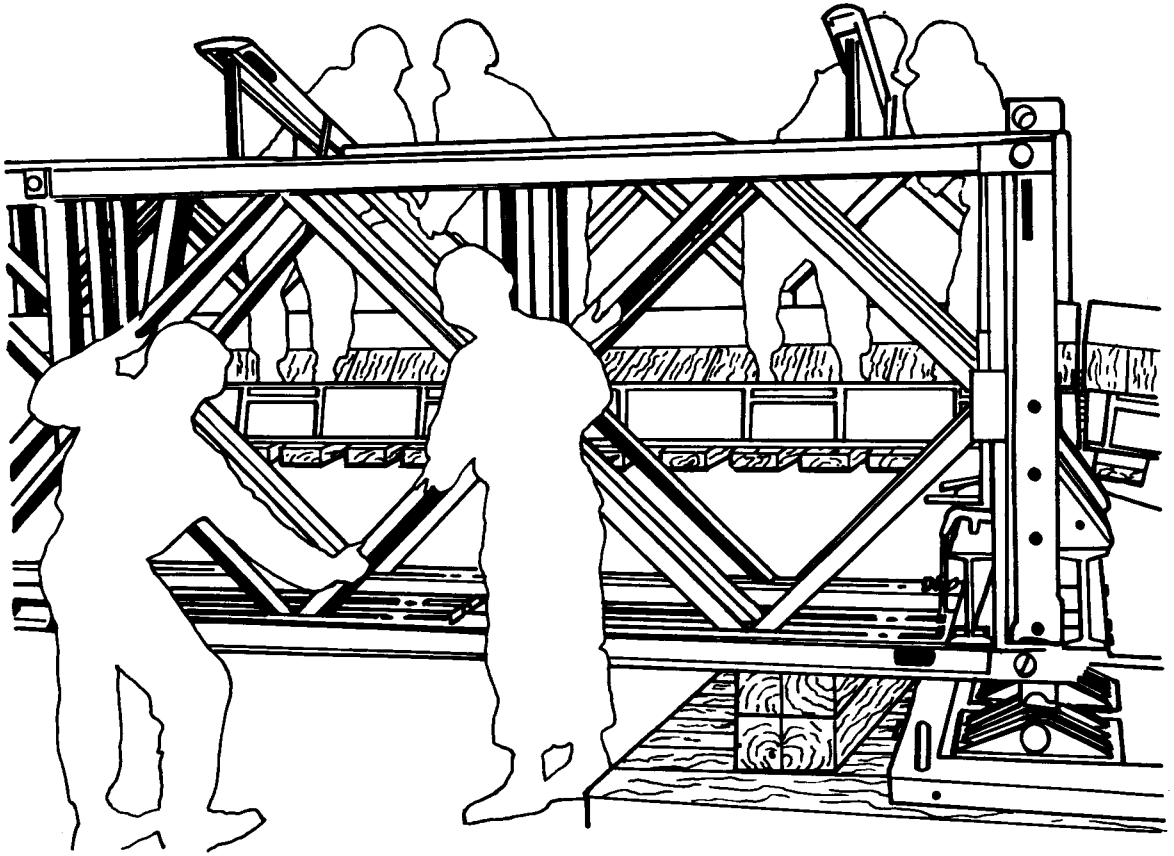


Figure 6-33 ***Inserting outer truss***

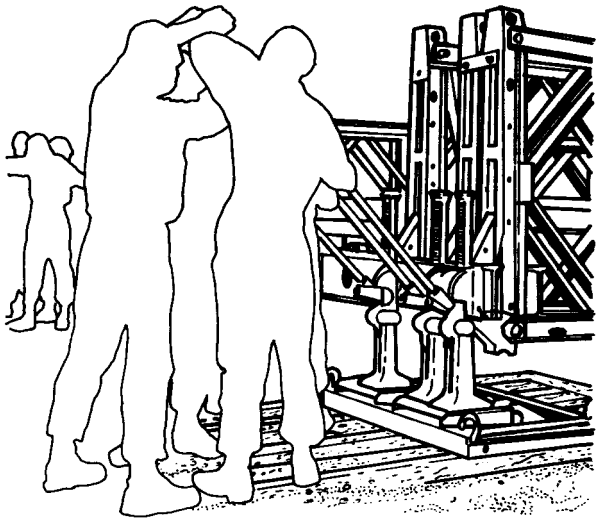


Figure 6-34 ***Jacking down after inserting the outer truss and shifting bearings***

CHAPTER 7

ASSEMBLY OF DOUBLE-STORY BRIDGES

THE DOUBLE-DOUBLE BRIDGE 94
THE TRIPLE-DOUBLE BRIDGE 97
LAUNCHING AND JACKING DOWN 98
REINFORCING BRIDGE AND CONVERTING BRIDGE 99

Methods of assembly for double-story bridges are similar to those used for single-story bridges. The second-story panels, however, can be hand carried from trucks or other platforms. Truck-mounted cranes, 5-ton wreckers, or gin poles can also be used. It is possible to assemble the second story during bridge assembly or after the bridge has been entirely launched. It is preferable, however, to assemble the entire bridge before pushing it across the gap. The same methods of launching are used as for single-story assembly. For long heavy bridges, it maybe necessary to use trucks or a bulldozer. The composition of the launching nose for the various combinations of spans and truss types is given in Tables 7-1 and 7-2. The tables must be followed exactly.

THE DOUBLE-DOUBLE BRIDGE

FIRST BAY OF BRIDGE

When the nose is completed, proceed with the first bay of the bridge as follows:

1 Assemble three bays of double-single bridge as shown in Figure 7-1 (page 96) and as described in Chapter 6.

2 Begin double-story assembly in the first bay of bridge with a separate working party (Figure 7-1). Continue bottom-story assembly at the same time, using the procedure for the single-story bridge. The second story always lags by two bays. Use an erection platform when placing second-story panels. Footwalks can be used as a working platform or panels can be hand carried from trucks maneuvered alongside the bridge (Figure 7-2, page 96). Panels must be loaded on trucks to allow standing room in the truck for the working parties. The second story is assembled as follows:

a Lift panel from truck at side of bridge. Place flat on top chord of bridge. Slide panel in toward center of bridge.

b Lift panel upright. Pivot so it is parallel to existing truss. Position and pin panel. Insert chord bolts, but do not tighten them.

c Repeat process with panels on outer truss.

d Position bracing frames on front and rear verticals and on top chord.

e Tighten chord bolts and bracing frame bolts.

f When footwalks are not used and trucks cannot be maneuvered alongside the bridge, second-story panels can be placed from a temporary deck inside the bridge or by the use of gin poles.

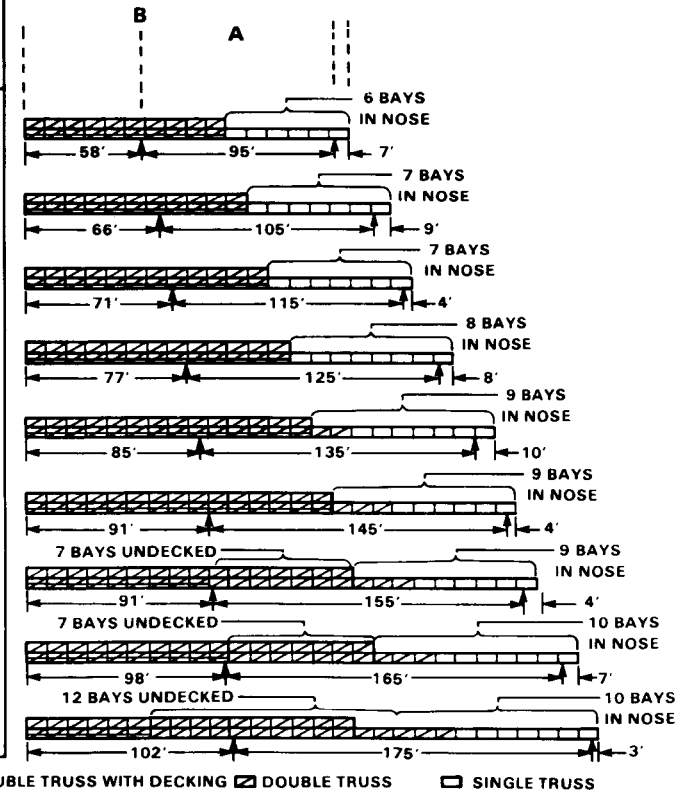
REMAINDER OF BRIDGE

The remainder of the bridge is built the same as the first bay except that bracing frames are positioned only on the rear verticals and top chord of the second story (Figure 7-1). When enough bays of bridge have been built to counterbalance the nose, move the bridge forward so the first bay is over the rocking rollers. Movement will not be necessary again during assembly unless the overhang at the

tail causes excessive sag. When adding panels from outside the bridge, place inner panels first with panel pins inserted from the outside. Then place outer truss panels with pins inserted from the outside. When adding panels from inside the bridge, place the outer panels first and insert all pins from the inside.

Table 7-1 ***Launching-nose composition for DD bridges***

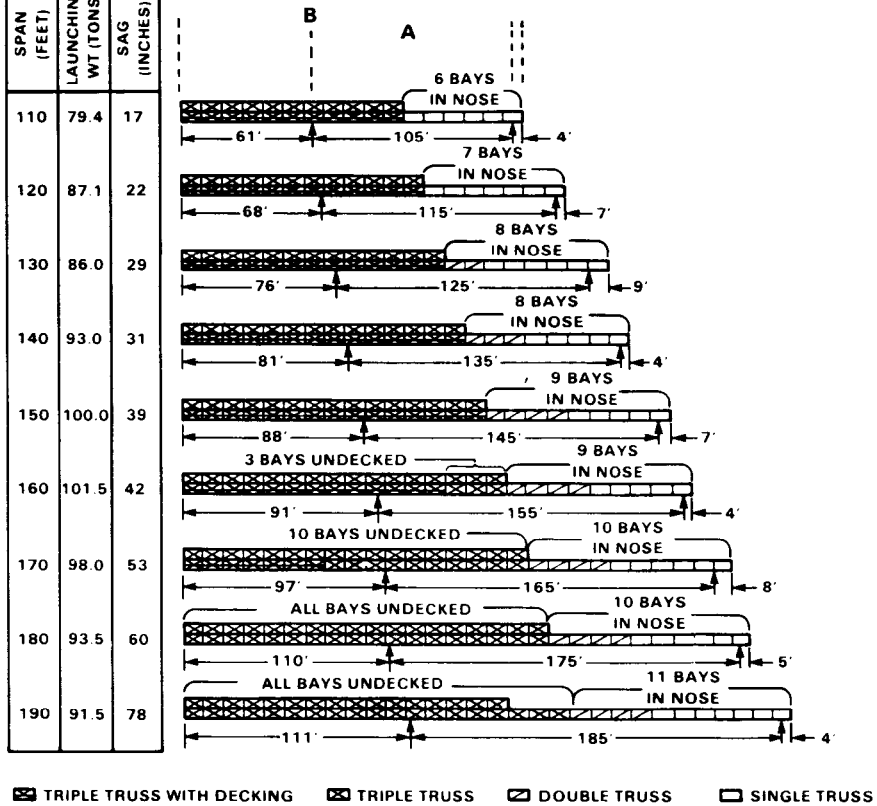
SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
100	60.5	17
110	59.0	22
120	63.5	24
130	69.0	31
140	76.0	38
150	81.5	41
160	75.5	45
170	81.0	57
180	76.0	68



Notes:
A = Distance between near and far bank rocking rollers
B = Balance point of bridge, ready for launching

Table 7-2 ***Launching-nose composition for TD bridges***

SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
110	79.4	17
120	87.1	22
130	86.0	29
140	93.0	31
150	100.0	39
160	101.5	42
170	98.0	53
180	93.5	60
190	91.5	78



Notes:
A = Distance between near and far bank rocking rollers
B = Balance point of bridge, ready for launching

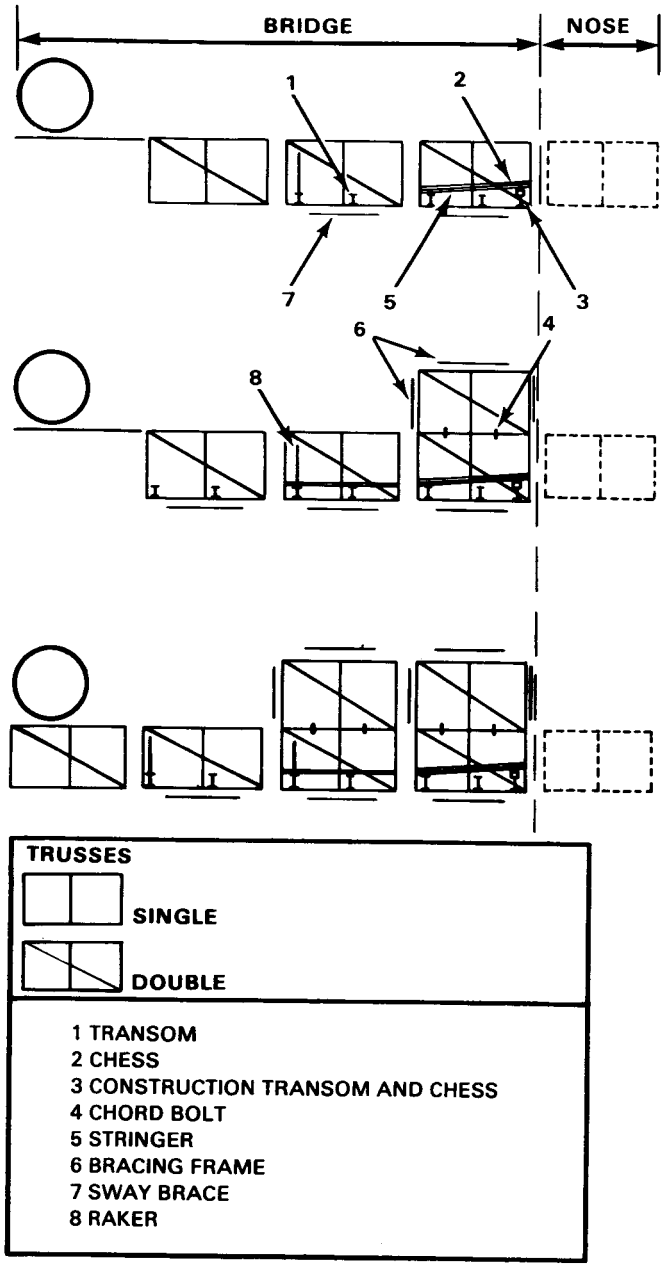
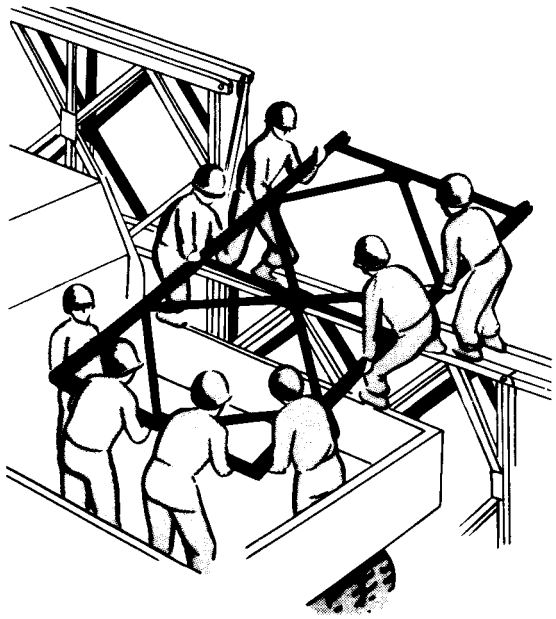
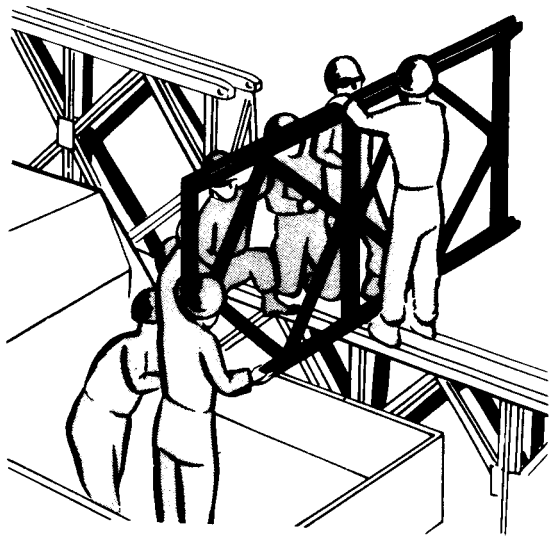


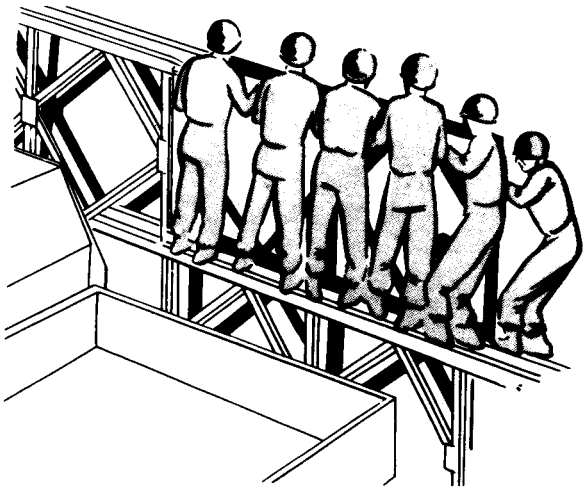
Figure 7-1 ***Assembly of DD bridge***



PICKING UP PANEL FROM TRUCK



LIFTING PANEL



PLACING PANEL

Figure 7-2 ***Adding second-story panels, using truck as working platform—lifting and placing panel***

THE TRIPLE-DOUBLE BRIDGE

METHOD OF ASSEMBLY

The triple-truss, double-story assembly (Figure 7-3) is essentially the same as double truss, double-story assembly. With triple-truss assembly, however, the outer truss in both the lower and second story must lag by one bay to allow insertion of the panel pins in the middle truss when panels are added from outside the bridge. When second-story panels are added from inside the bridge, the inner and middle trusses must lag by one bay to allow insertion of the panel pins in the outer truss.

LAUNCHING NOSE

The composition of the launching nose is the same as that for the *double-double* bridge. For the length and assembly of nose required for various spans, see Table 7-2.

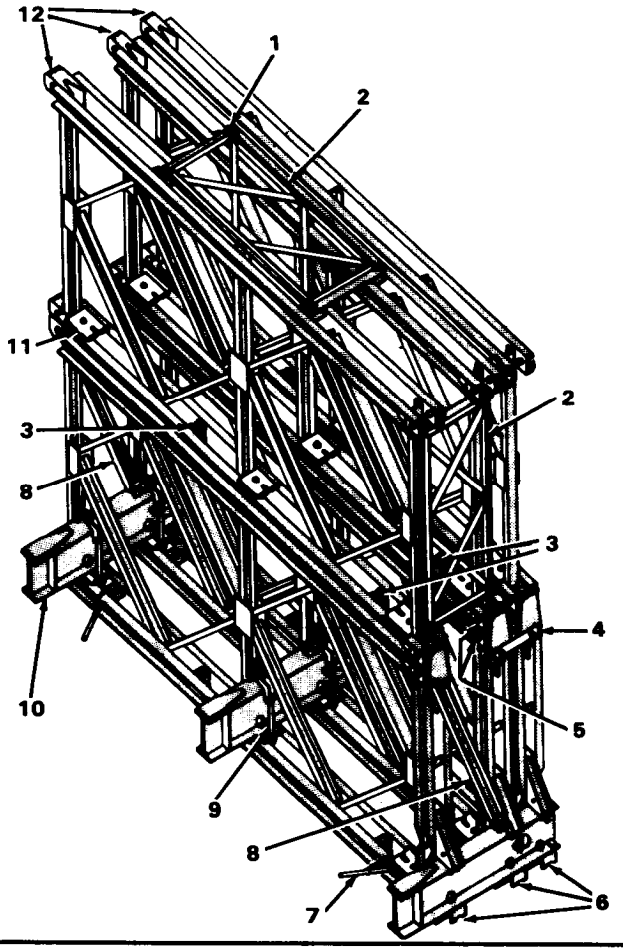
FIRST BAY OF BRIDGE

When assembly of the nose is completed, proceed with the first bay of the bridge as follows:

1 Assemble four bays of single-story bridge as shown in Figure 7-4 (page 98) and described in Chapter 6.

2 Add double-story assembly using the same assembly method as for the *double-double* bridge (Figure 7-1).

3 Position bracing frames on the front and rear verticals and on the top chord of the first bay of bridge before the chord bolts are tightened.



1 BRACING BOLT	5 PANEL PINS	9 TRANSOM CLAMP
2 BRACING FRAME	6 MALE END POSTS	10 TRANSOM
3 CHORD BOLTS	7 SWAY BRACE	11 TRANSOM SEAT
4 TIE PLATE	8 RAKER	12 PANELS

Figure 7-3 Location of bridge parts in trusses of TD bridge

This change supersedes page 98.

REMAINDER OF BRIDGE

Assemble the remainder of the bridge the same as the first bay, but position bracing frames only on the rear verticals and top chords of the second story. Connect outer truss to middle truss with tie plates bolted to the top raker holes in the forward panel uprights of both stories. See Chapter 4 for ramp construction and Chapter 9 for traffic control.

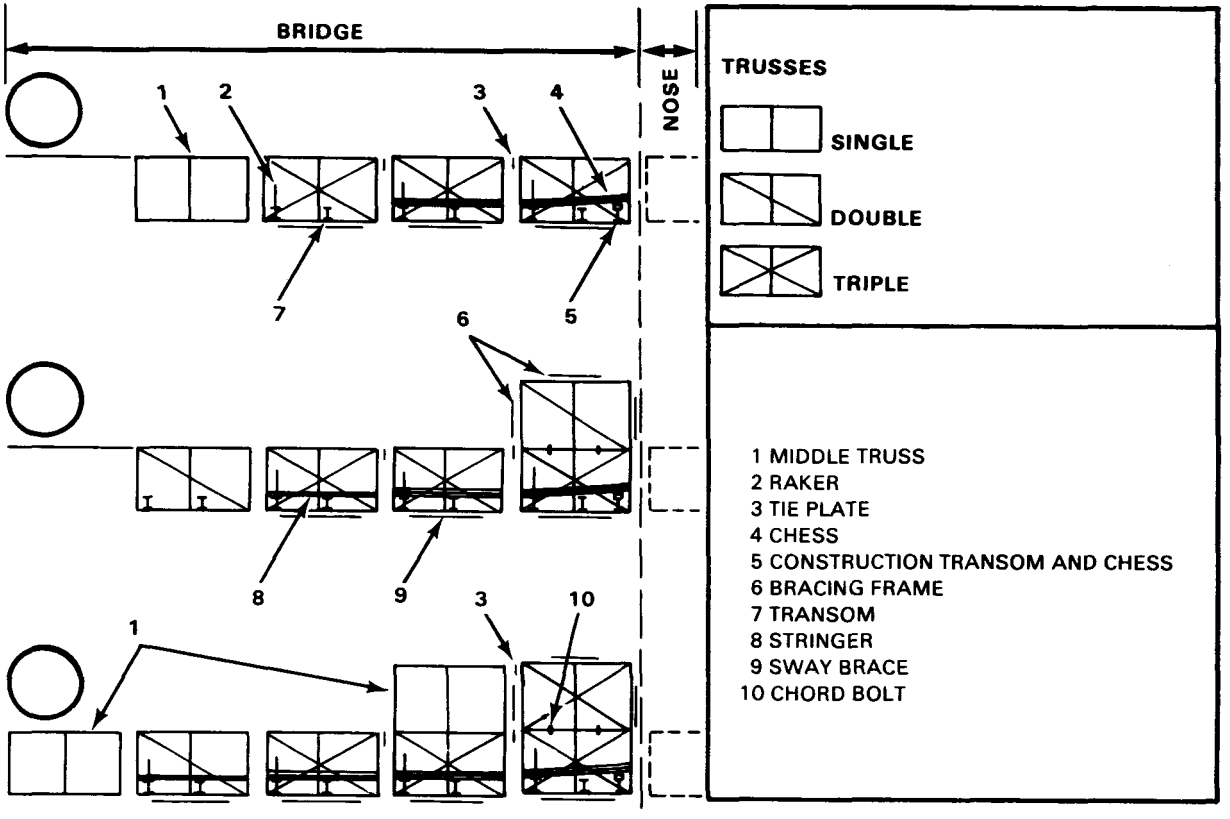


Figure 7-4 ***Assembly of first bay of TD bridge***

LAUNCHING AND JACKING DOWN

LAUNCHING

Launching of double-story bridges normally begins after the assembly of the entire bridge. Use the same launching methods and precautions as for launching single-story bridges. When launching with bulldozers or trucks, take the following precautions:

- Do not apply power directly to the end of a panel except at the junction of the diagonals. Apply it against the end posts, or a transom at the junction of the diagonals (Figure 7-5). When applying power against a transom, make sure it is distributed across the length of the transom.
- Roller heights must be fixed so that the tail of the bridge is at least 6 inches (15.2 centimeters) off the ground during the entire launching.
- Rig a line to control lateral movement of the bridge.
- If the bridge requires two trucks or bulldozers to move it, use one against the end post of each girder.
- When using a bulldozer, bolt ribbands at the tail of the bridge so they extend beyond the end of the bridge. Place a

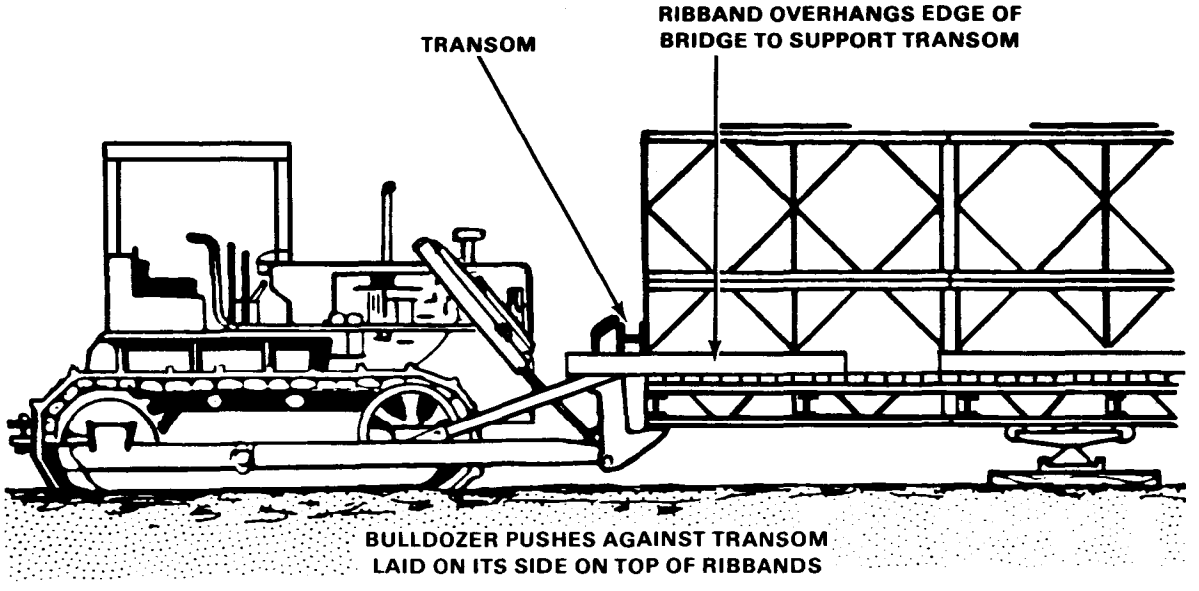

TRANSOM
RIBBAND OVERHANGS EDGE OF BRIDGE TO SUPPORT TRANSOM
BULLDOZER PUSHES AGAINST TRANSOM LAID ON ITS SIDE ON TOP OF RIBBANDS

Figure 7-5 ***Using bulldozer to launch bridge***

transom on its side on the ribbands so the transom rests against the end vertical at the junction of the diagonals. Face transom lugs toward the nose of the bridge. Control lateral movement of the bridge by fastening winch lines from two trucks to male panel holes for positive control. Launch the bridge with the bulldozer blade pushing against the transom (Figure 7-5).

JACKING DOWN

Use the same jacking methods and precautions used for single-story bridges (Chapter 6).

REINFORCING BRIDGE AND CONVERTING BRIDGE

METHOD

The class of existing single-story bridges can be increased by adding extra stories. For all assemblies over class 70, the decking system must be reinforced by increasing the number of transoms per bay from two to four, and by adding a 3-inch (7.6 centimeters) longitudinal wear tread.

CONVERTING DOUBLE-SINGLE TO DOUBLE-DOUBLE

To convert an existing double-single bridge to a double-double bridge, proceed as follows:

1 Remove bracing frames.

2 Carry first panel to midpoint of bridge and place on top chord of existing bridge. Erect outer truss first (Figure 7-6, page 100). Before raising panels, insert wrenches in the top chord of the existing bridge to prevent the panel from skidding out. The inner truss assembly should follow closely behind the outer truss in order to speed construction.

3 Insert chord bolts and panel pins. Where necessary, use chord jacks (Figure 7-7, page 100) to overcome sag when inserting panel pins. Tightening chord bolts also helps reduce difficulty caused by sag. Chord jacks are not required when adding a second story to double-truss spans 120 feet (36.6 meters) or less in length if the following method is used simultaneously on both sides of the bridge:

a Place first panel of second story at center of bridge and insert chord bolts. Do not tighten bolts.

b Place a panel at each end of the center panel of the second story. Insert chord bolts and upper panel pins.

c Tighten all chord bolts to reduce sag. Drive lower panel pins with a sledge hammer.

d After the first three panels are in place, add other panels, one at a time, working toward both ends of the bridge.

e As each panel is placed, insert chord bolts. Do not tighten until the upper panel pin has been inserted.

f It maybe necessary to drive upper and lower panel pins simultaneously, starting at the ends of the bridge. Tighten chord bolts to reduce sag.

g Place bracing frames vertically on the same end of successive panels and horizontally along the top chord of the second story.

See Figure 7-8 for partially completed bridge.

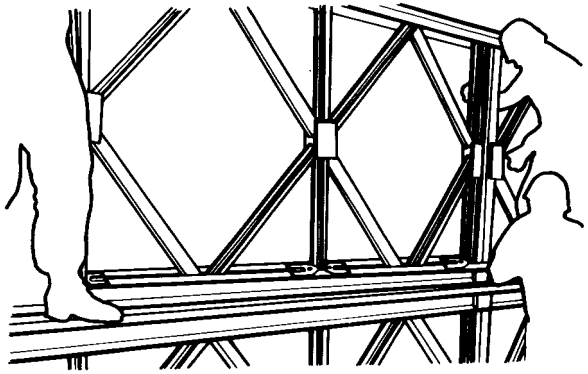
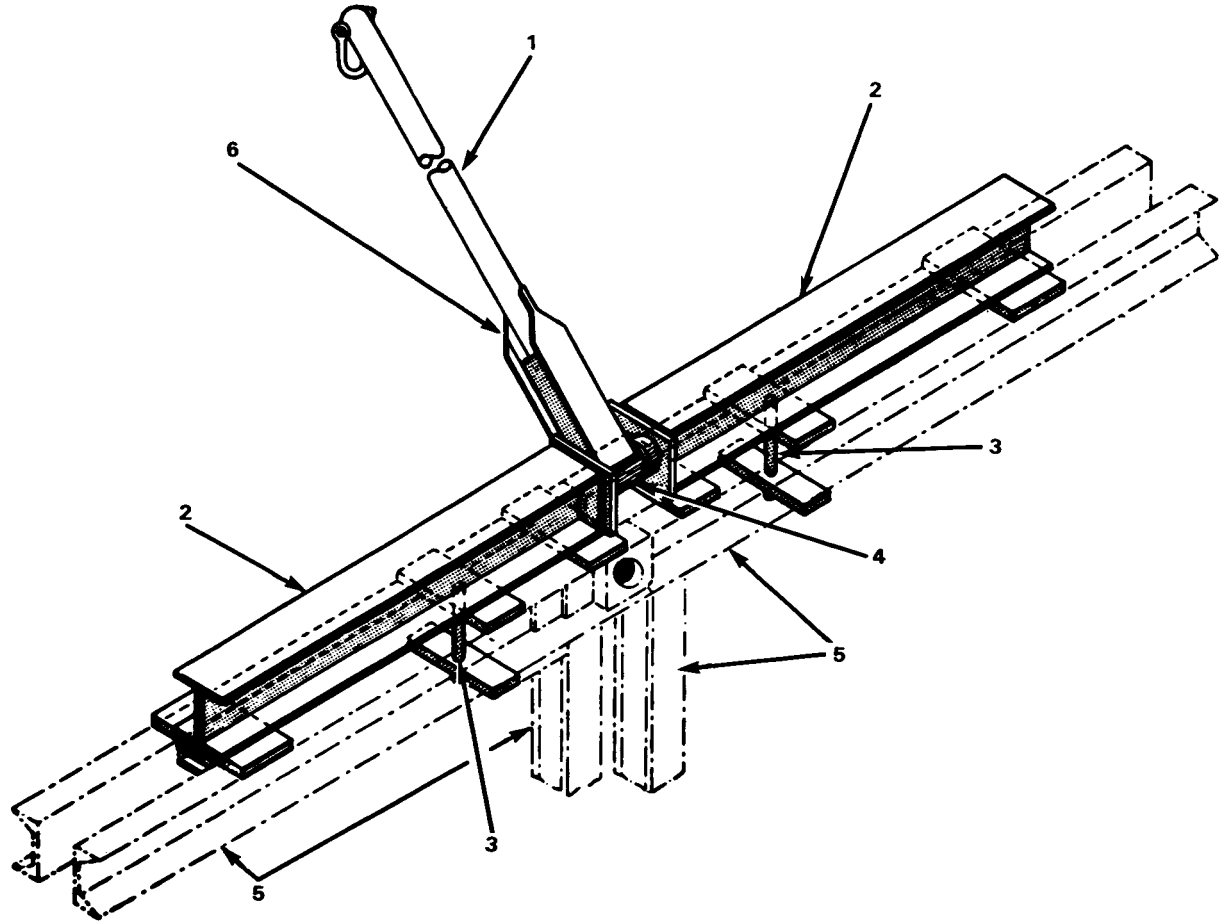


Figure 7-6 ***Outer second-story panel in position before insertion of panel pins***



1 RATCHET LEVER
2 CHORD JACK FRAME
3 BOLT THROUGH CHORD
4 JACK SCREW
5 PANEL
6 CHORD JACK HANDLE

Figure 7-7 ***Chord jack in position on top chord***

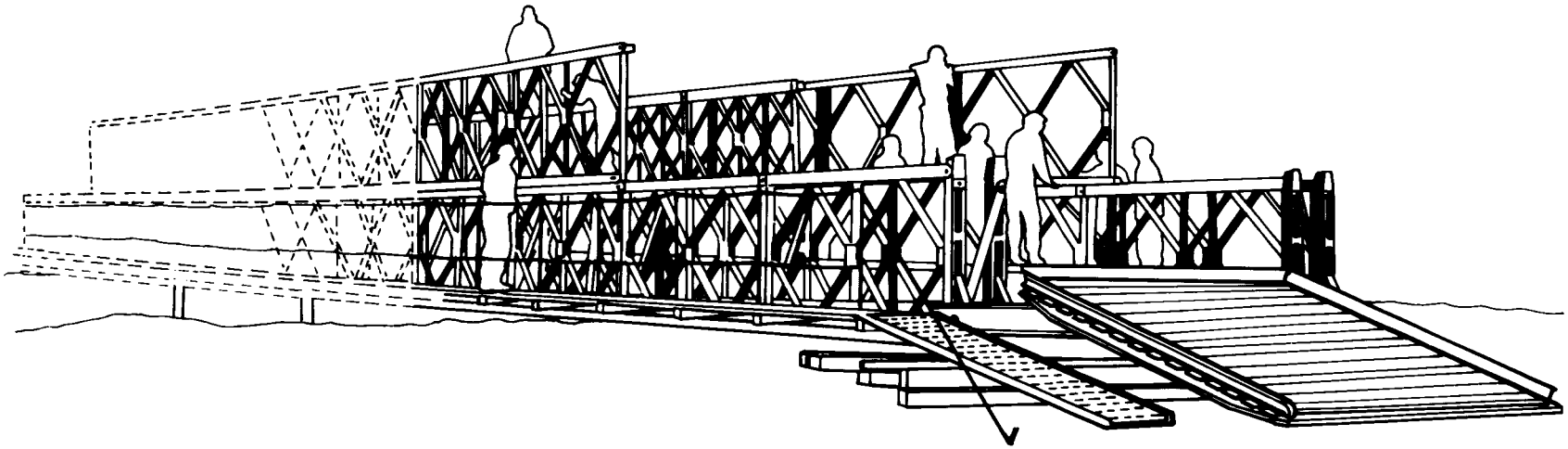


Figure 7-8 ***Converting DS to DD bridge in position***

CHAPTER 8

ASSEMBLY OF TRIPLE-STORY BRIDGES

LAUNCHING NOSE AND OVERHEAD BRACING 103
THE DOUBLE-TRIPLE BRIDGE 107
THE TRIPLE-TRIPLE BRIDGE 107
ASSEMBLY OF BRIDGES WITH UNDERSLUNG STORY 109

This chapter describes the assembly and composition of triple-story bridges and their launching noses. The normal cantilever method used for launching single- and double-story bridges is used for launching triple-story bridges. However, some triple-story bridges must be launched incomplete to reduce launching weight.

Triple-story bridges are normally assembled by truck-mounted cranes. If cranes are not available, parts can be placed with gin poles, 5-ton wreckers, or carried by hand. Triple-story bridges can be assembled with all three stories above the decking system (Figure 8-1) or with one story underslung (Figure 8-2). When all three stories are above the decking system, the top chord of the upper story must be braced laterally with transoms and sway braces. When one story is below the decking system, lateral bracing in the bottom chord of the underslung story is required only when the wind velocity is more than 50 miles (80.6 kilometer) per hour. The class of triple-story bridges is not affected by the location of the deck or by the omission of one story of panels in each end bay.

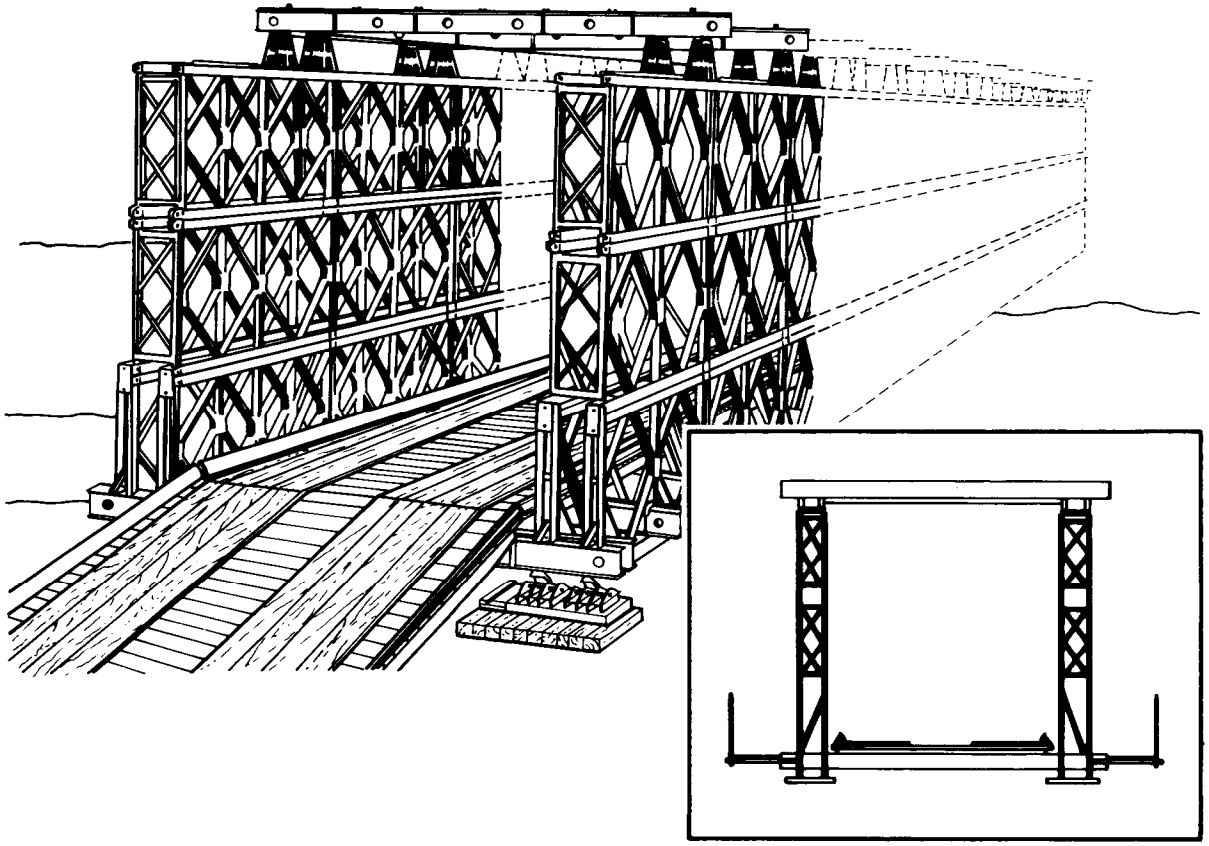


Figure 8-1 ***Triple-story bridge with all three stories above the decking system (using overhead-bracing supports)***

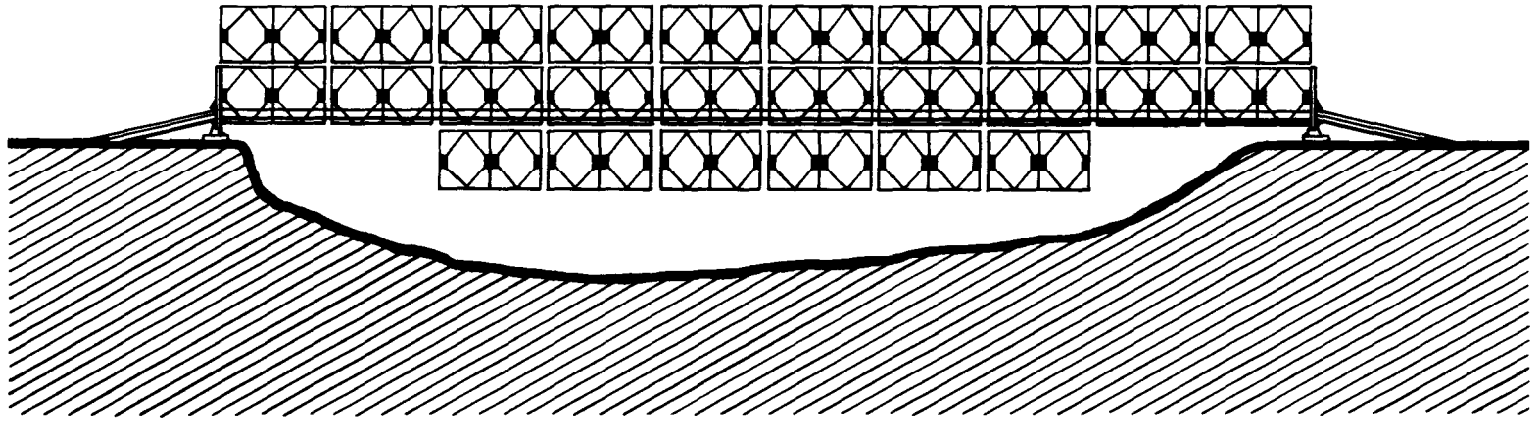


Figure 8-2 ***Triple-story bridge with underslung story***

LAUNCHING NOSE AND OVERHEAD BRACING

LAUNCHING NOSE ASSEMBLY AND COMPOSITION

Assembly of the launching nose for triple-story bridges is the same as for single- and double-story bridges. However, the launching weight of the nose and bridge is limited by the 120-ton (108.8 metric tons) capacity of the near-bank rocking rollers and the lower-bridge chords which they support. The composition of the launching nose for the various combinations of span and bridge assembly is given in Tables 8-1 and 8-2 (page 104). These tables must be followed exactly.

OVERHEAD BRACING

The upper story of triple-story bridges, with all three stories above the floor system, is braced by using overhead-bracing supports with transoms and sway braces on the top chord of the upper story (Figure 8-l). Another method is to invert the third-story panels and place transoms and sway braces in their normal seating on the inverted panels.

With overhead-bracing supports

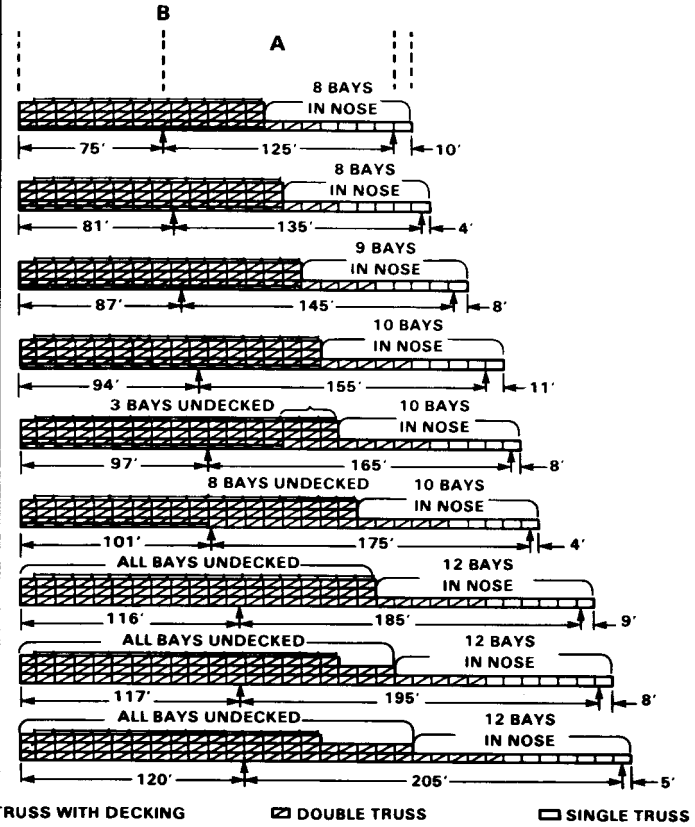
When overhead-bracing supports are used, place one support per girder on each bay of the bridge. Position the supports on panels of the inner and second truss over the chord-bolt holes nearest to the female lugs. This provides clearance for the bracing frames on the top chord. Fasten transoms to the tops of the supports and pin sway braces to the projecting ears on the supports (Figure 8-3, page 105).

Without overhead-bracing supports

When overhead-bracing supports are not used, the panels of the third story must be inverted so that transoms and sway braces can be inserted (Figure 8-4, page 106). Transoms are fitted on the transom seats beneath the upper chord of the top story and are held in place by transom clamps. Sway braces are placed in the sway-brace holes in the sides of the upper chord of the third-story panels. One transom and two sway braces are used per bay.

Table 8-1 ***Launching-nose composition for DT bridges***

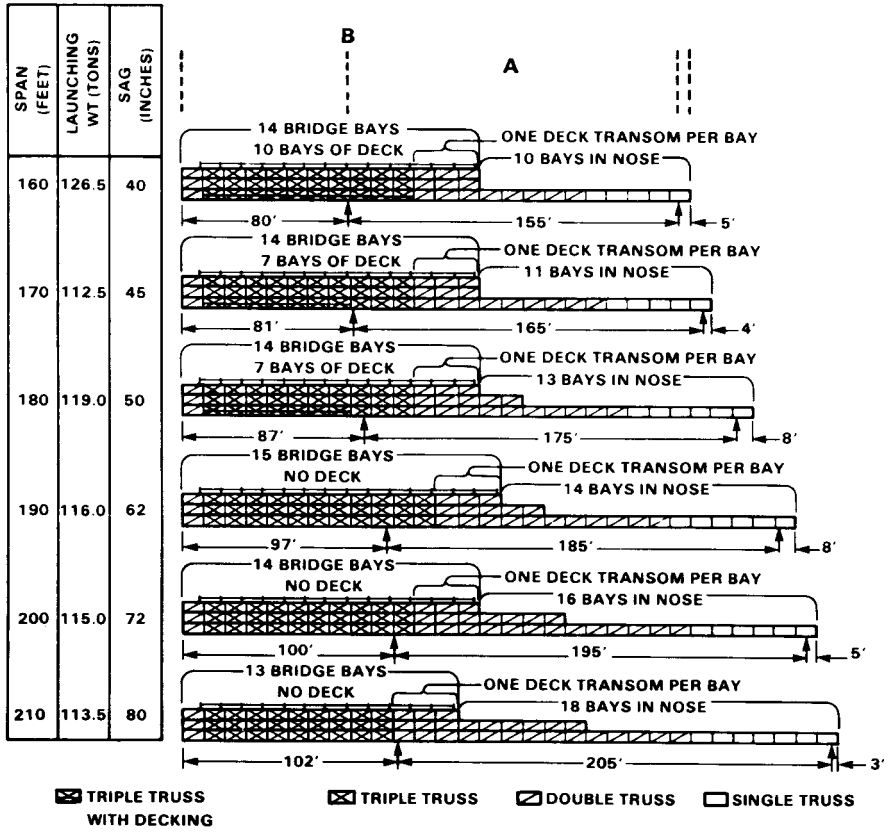
SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
130	104.2	25
140	101.0	27
150	109.0	34
160	117.0	42
170	119.0	45
180	118.5	47
190	111.0	60
200	110.5	72
210	112.0	80



Notes:
A = Distance between near and far bank rocking rollers
B = Balance point of bridge, ready for launching

Table 8-2 ***Launching-nose composition for TT bridges***

SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
160	126.5	40
170	112.5	45
180	119.0	50
190	116.0	62
200	115.0	72
210	113.5	80



Notes:
A = Distance between near and far bank rocking rollers
B = Balance point of bridge, ready for launching

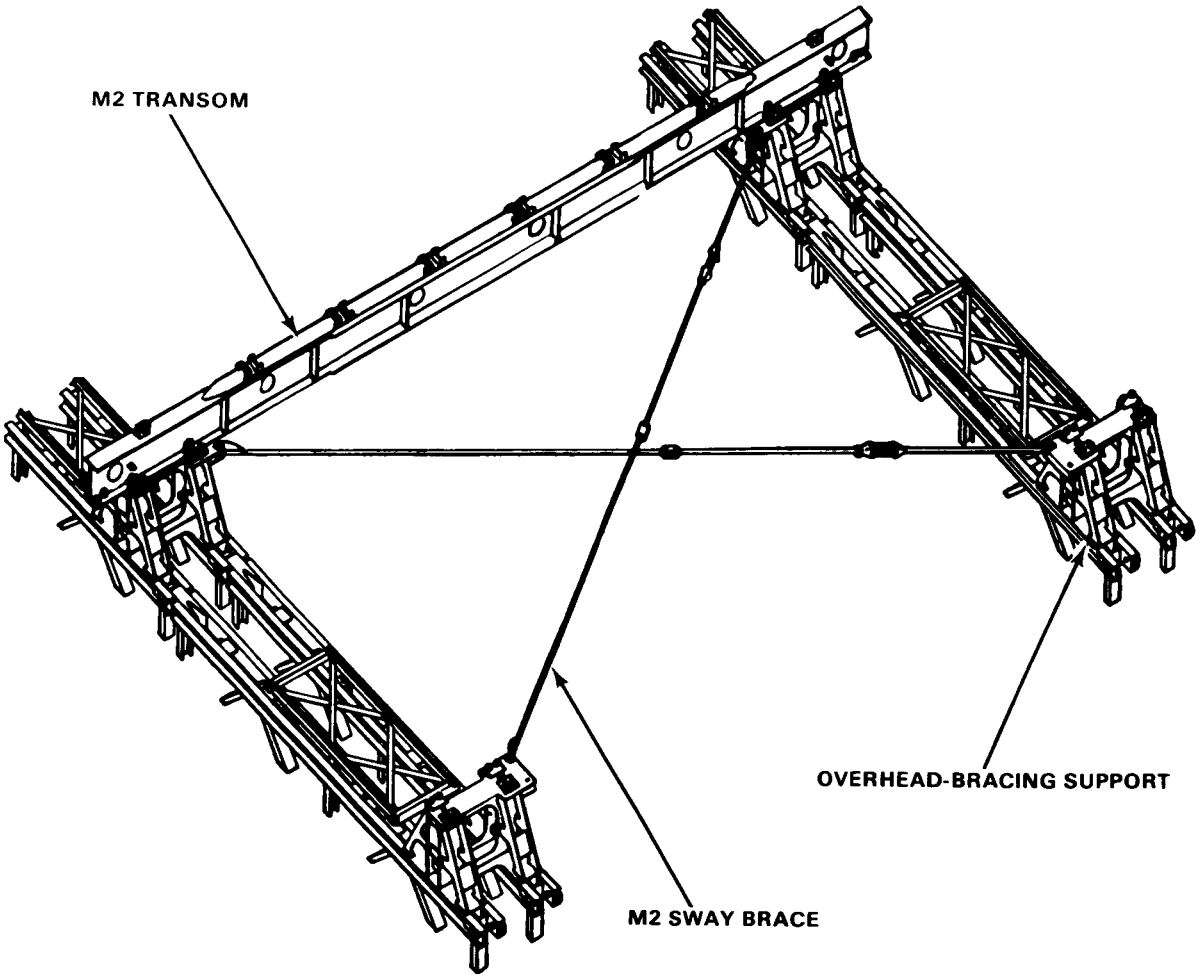


Figure 8-3 ***Location of bridge parts in overhead bracing of DT bridge***

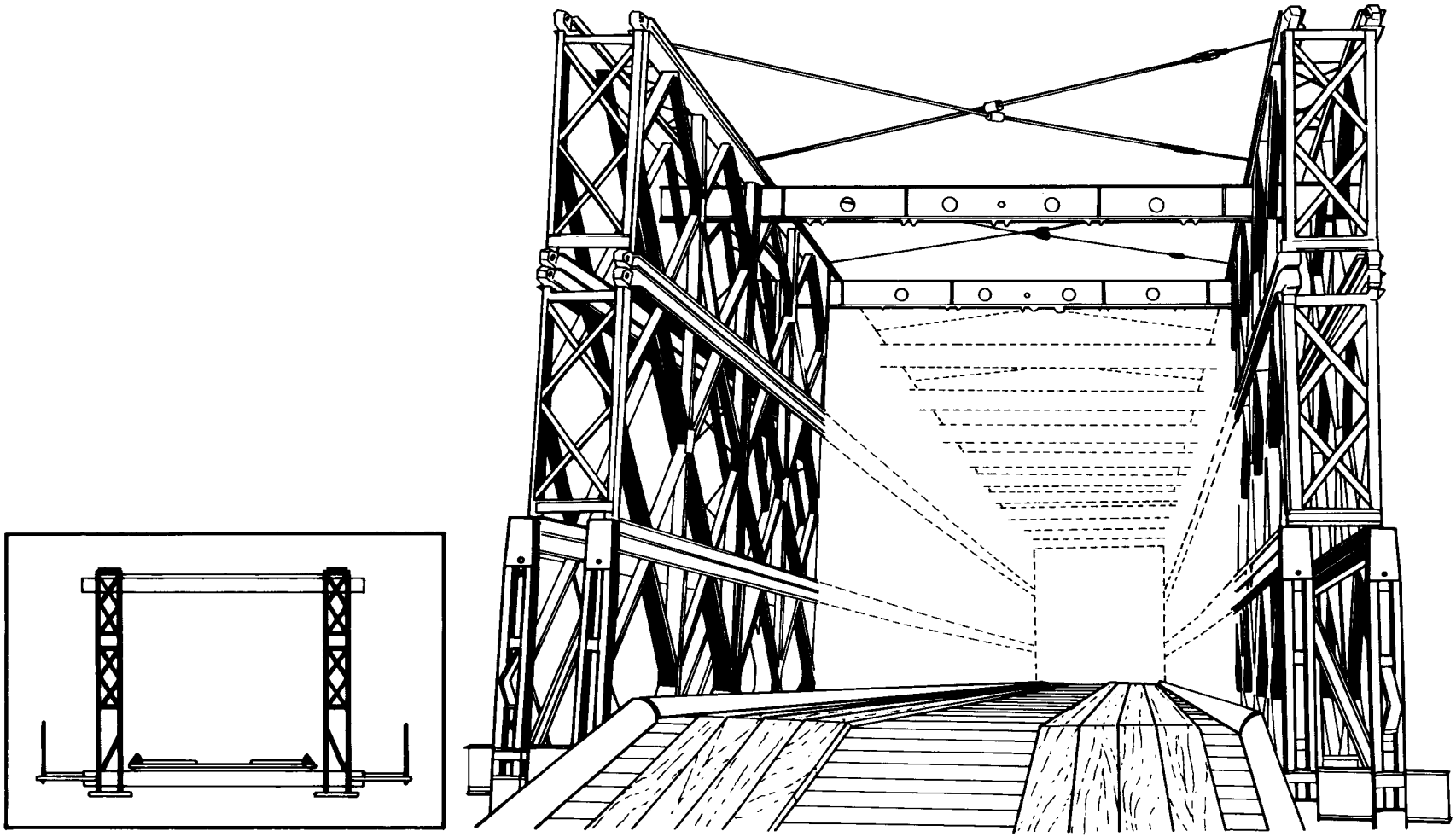


Figure 8-4 ***Overhead bracing on triple-story bridge with bracing in inverted third-story panels***

THE DOUBLE-TRIPLE BRIDGE

DESCRIPTION

Double-triple bridges are normally assembled bay by bay on rollers and launched complete. Some of the longer, spans, however, must be launched incomplete to reduce the launching weight.

METHOD OF ASSEMBLY

When assembly of the nose is completed, assemble the first bay of the bridge as follows:

1 Connect inner and outer truss panels to last bay of nose. Assemble parts into place.

2 Add transoms, bracing, and decking in the same way as for single-story bridges.

3 Add panels to second and third story with cranes. Stockpiles are located near cranes to aid handling. Place bracing frames on front and rear panel verticals in second and third stories and on top chord of third story.

4 Lift overhead-bracing supports with cranes and position over chord-bolt holes nearest female lugs of panels. Bolt to girder on one side of bridge only. Bolts on other side are left out because bolt holes may not line up when transom is placed on supports, since the girders tend to lean slightly toward center.

5 Position overhead transom and fasten by the two clamps on each support.

6 Insert jack between support that is not bolted and outer truss of bridge. Force girders out and insert two chord bolts in the support.

7 Position overhead sway braces but do not tighten until overhead transom in next bay has been fixed.

8 Place the rest of the panels with cranes. Assemble on the ground a single-truss section of two panels connected by chord bolts. When the two-panel section is completed, attach a sling and lift the section into place by a crane. Insert top panel pins first and bottom ones next.

9 Add the transoms and deck while assembling the rest of the stories.

THE TRIPLE-TRIPLE BRIDGE

DESCRIPTION

Triple-triple assembly is uncommon. Its heavy launching weight could cause failure of the rollers or lower chord of the bridge. For this reason, special methods must be used for assembling *triple-triple* bridges.

ASSEMBLY AND LAUNCHING

Triple-triple bridges can be launched incomplete or by using a temporary launching pier. *Triple-triple* bridges are launched incomplete, using the assembly given in Table 8-2, to reduce launching weight and prevent overload of the rollers. The bridge is assembled and launched as follows:

1 Assemble nose and partial bridge exactly as shown in Table 8-2 according to span length, and launch to far-bank rollers using normal methods of assembly and launching.

2 Continue launching bridge over gap until near-bank rocking rollers are under last *triple-triple* bay of bridge. Dismantle nose beyond far-bank rocking rollers (Figure 8-5, page 108).

3 Make near-bank end *double-triple* bay *triple-triple,* and add enough *triple-triple* bays to obtain required bridge length (six more *triple-triple* bays at most). This gives the required bridge length for all but the 210-foot (64 meters) span. Because of staggered assembly, the end bay of the latter bridge must be left *double-triple* at this point. Decking in 180-foot (54.9 meters) and shorter spans can be continued to the end of the bridge (Figure 8-5).

4 Continue launching bridge until the near-bank rocking rollers are again under the last *triple-triple* bay of bays added (Figure 8-5).

5 Add five bays of *double-single* nose to the near-bank end of all bridges (Figure 8-5). Add two more bays to the 210-foot (64 meters) bridge to get the required bridge length before adding this tail assembly.

6 Launch bridge forward until the three *double-triple* bays at front of bridge are beyond far-bank rollers. Complete *double-triple* bays by converting to *triple-triple* and adding transoms (Figure 8-5).

7 Pull bridge back to final position, remove *double-single* tail, and complete assembly in usual manner (Figure 8-5).

Triple-double bridges can be launched using a temporary launching pier. Assemble and launch a normal *triple-double* bridge. At the same time, assemble a temporary launching pier from panel-bridge parts. The pier can be offset from the center of the gap so the short span is not less than 60 percent of the long span. After the pier is completed, place a platform on top of it to carry jacks. When the *triple-double* bridge has been jacked down onto the bearings, insert jacks under the bridge at the pier, and jack up the bridge to about horizontal. Then use a truck crane to place the third-story panels and the overhead bracing. Jacking most of the sag out of the bridge makes it possible to place the third-story panels. When a fixed pier cannot be used, use a floating pier. The pontons are partly filled with water to float the pier under

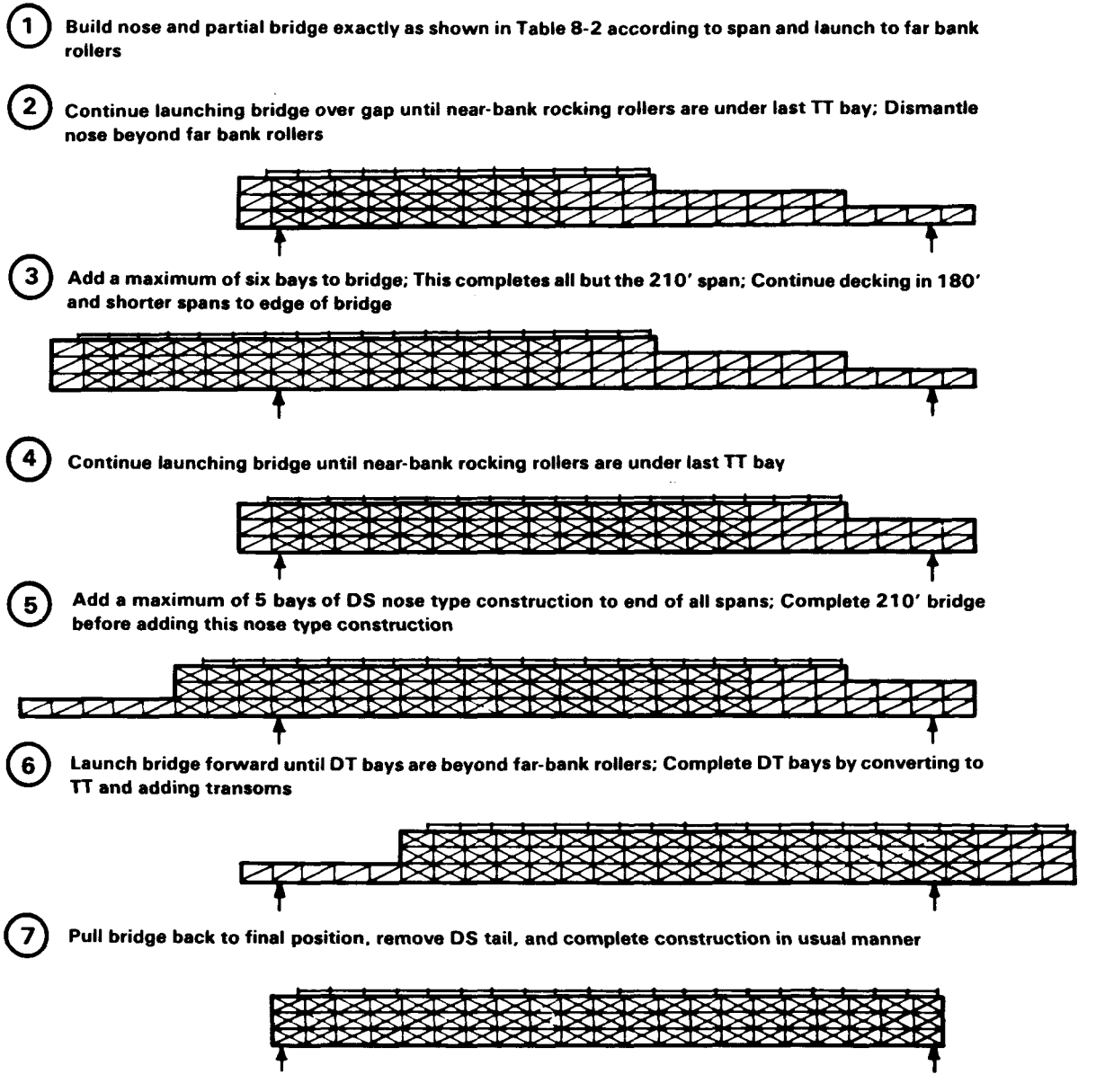

1 Build nose and partial bridge exactly as shown in Table 8-2 according to span and launch to far bank rollers
2 Continue launching bridge over gap until near-bank rocking rollers are under last TT bay; Dismantle nose beyond far bank rollers
3 Add a maximum of six bays to bridge; This completes all but the 210' span; Continue decking in 180' and shorter spans to edge of bridge
4 Continue launching bridge until near-bank rocking rollers are under last TT bay
5 Add a maximum of 5 bays of DS nose type construction to end of all spans; Complete 210' bridge before adding this nose type construction
6 Launch bridge forward until DT bays are beyond far-bank rollers; Complete DT bays by converting to TT and adding transoms
7 Pull bridge back to final position, remove DS tail, and complete construction in usual manner

Figure 8-5 ***Assembly and launching of incomplete TT bridge***

the bridge, and the water is pumped out to raise the bridge. Information on pier reactions is given in Chapter 16, and on panel crib piers in Chapter 17.

VERTICAL CLEARANCE

The vertical clearance in triple-story bridges is of prime importance when loaded tank transporters are to pass over them. This is especially true when expedient overhead bracing is used. If greater vertical clearance is needed, underslung stories or deck-type construction may be used to provide the required bridge class.

USE OF MECHANICAL MEANS

It is normally necessary to launch triple story bridges by mechanical means. Take special care to see that the assembly of the bridge and nose is correct and that the rollers are properly leveled. The launching weight of these bridges is high and slight errors can cause failure.

JACKING DOWN

Normal jacking down methods cannot be used for triple-story bridges. There is not enough room at the end posts to use the required number of jacks. Use either jacks of higher capacity or the methods of jacking down bridges on intermediate piers. Using intermediate pier methods requires room ahead of the bearings for placing the jacks and the timber grillage under the bottom chord to catch the bridge if the jacks slip or fail.

ASSEMBLY OF BRIDGES WITH UNDERSLUNG STORY

METHODS

Triple-story bridges with underslung story are normally assembled and launched by one of the following methods:

- Launched with underslung story, using a temporary launching pier at center of gap. This method is normally used when the launching pier can be positioned.
- Launched as double-story bridge, with underslung story added after bridge is in place. This method is normally used when the launching pier cannot be positioned.
- Launched as double-story bridge, jacked down approximately 6 feet (1.8 meters), with third story added on top chord. This method requires jacking the bridge an excessive distance and generally is not used.

USING TEMPORARY LAUNCHING PIER

This method requires a temporary intermediate launching pier at the center of the gap. It also requires enough room under the near-bank abutment to add one story of underslung panels. The bridge is assembled and launched as follows:

1 Assemble a panel crib pier at the center of the gap strong enough to carry the completed triple-story bridge (Chapter 17). The pier must have at least two bays of panels horizontal (Figure 8-6, page 110). On the pier bay toward the far bank, place rocking rollers at same elevation as near-bank rollers. On the near-bank side of the pier, assemble a bay one panel height below the bay toward the far bank, and place rocking rollers.

2 Assemble double- or triple-truss single-story bridge using normal launching nose and assembly methods for abridge length equal to one half the width of the gap (distance from near bank to forward rocking rollers on pier).

3 As soon as the launching nose has landed on the pier rocking rollers on the far-bank side of the pier, add underslung panels, starting with the second bay of bridge.

4 Continue launching the double-or triple-truss single-story bridge and adding the underslung story until the underslung story reaches the pier (Figure 8-6).

5 When the underslung panels land on the pier rocking rollers on the near-bank side of the pier (Figure 8-6), remove the pier rocking rollers under the launching nose. Also remove the top bay of panels on the far-bank side of the pier under the launching nose.

6 Continue launching until bridge lands on far-bank rocking rollers. Remove launching nose and position end posts. Before jacking bridge down onto bearings, remove one complete story from pier and place a working platform on the pier.

7 Jack up center of bridge at intermediate pier until bridge is approximately level. This reduces sag and eliminates difficulty in placing third-story panels.

8 Add third-story panels by using truck crane or truck, or by hand.

9 Remove construction pier. Bridge is now complete.

ASSEMBLY IN PLACE

An underslung story can be added to a double-story bridge in place by using a truck crane. This is the easiest and fastest way. Lower single panels over the side with a truck crane and attach them with chord bolts. Place inner panels first. Use blocks and tackle to position the inner truss panels. Other truss panels can be positioned directly with the crane.

When a truck crane is not available or when it causes too much sag in the bridge, the underslung story can be added as follows:

1 After the double-story has been assembled and launched, position plain rollers outside of and about 10 inches (25.4 centimeters) from the existing outside truss. Place the front roller 3 feet 6 inches (1.07

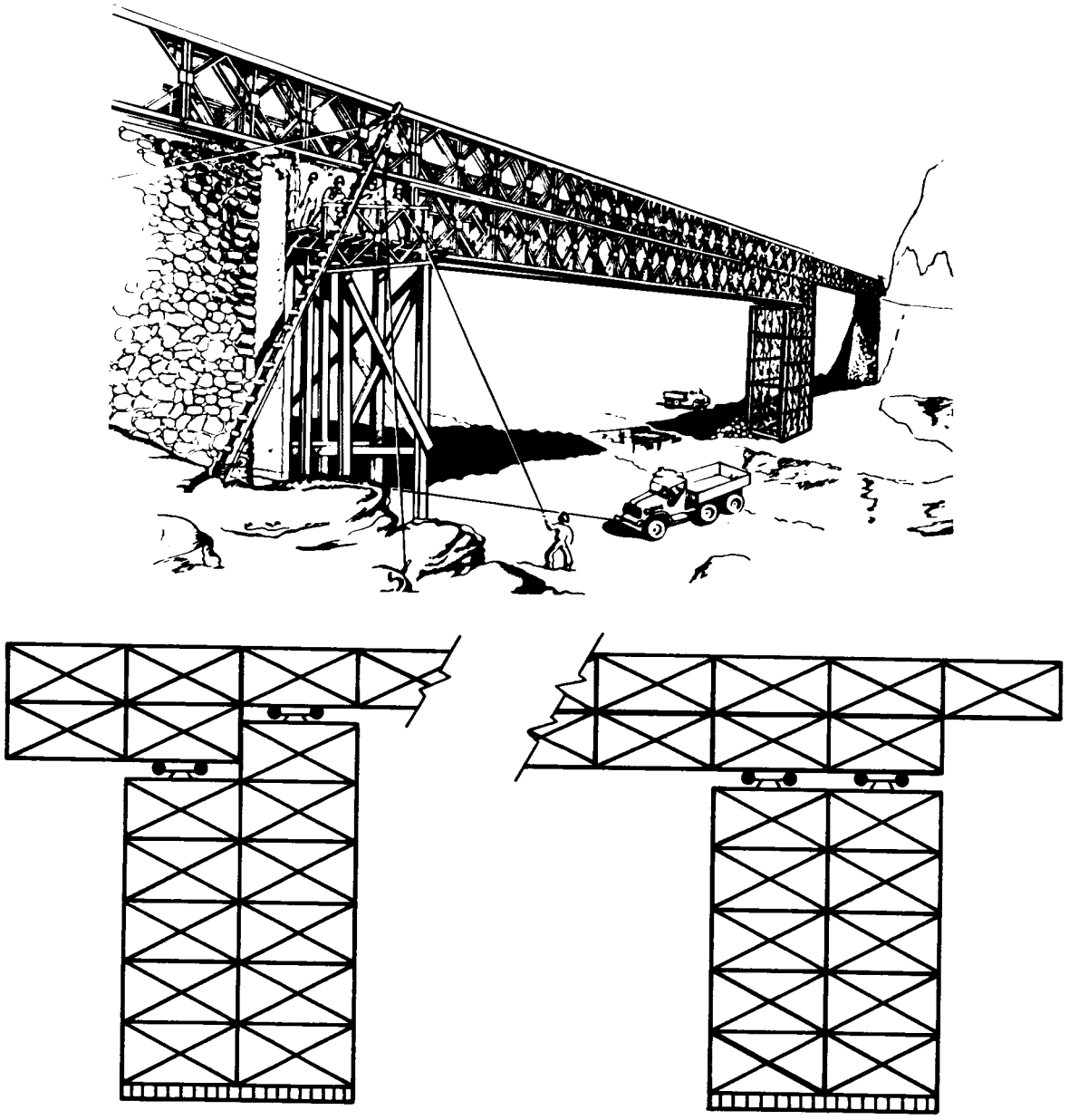


Figure 8-6 ***Underslung panels on rocking rollers in first bay of pier***

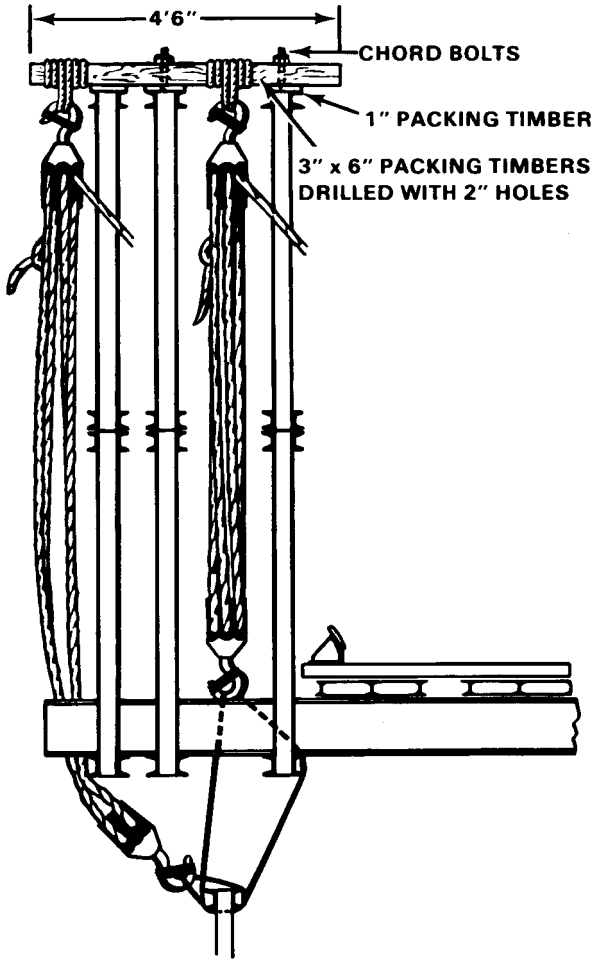


Figure 8-7 ***Positioning underslung single-truss girder using block and tackle***

meters) from the base plate position and another roller 25 feet (7.62 meters) from the first. Additional rollers 25 feet (7.62 meters) apart can be placed if necessary.

2 Assemble a single-truss girder one half of the total length of the bridge minus one bay (not to exceed 12 bays).

3 Attach one raker per bay to the bottom bracing-frame hole on the inner truss panel chord. Lay rakers flat across the bottom chords of the panels so they project beyond the side of the bridge and over the gap.

4 Place 3-by 6-inch (7.6 by 15.2 centimeters) packing timbers on top chord of bridge in every fourth bay. Hold in place with chord bolts through chord-bolt holes nearest female lugs. Place l-inch (2.54 centimeters) timber packing between grillage and chord. Suspend double-or triple-block and tackle from each timber, one at outside end and one between first and second truss.

5 Launch single girder over plain rollers on bank and rakers on bridge until it is in position to be lowered. Attach outer tackle to girder, remove rakers, and then lower girder until top chord is below bottom chord of the bridge. Attach inside tackle below the bottom chord of the bridge to the girder with a sling which passes around the bottom chord of the inner truss of the bridge (Figure 8-7).

6 Remove outer tackle and lift girder into position under lower chord of bridge with inner tackle.

7 Insert chord bolts and tighten to fix girder into position.

8 Remove inner tackle and repeat procedure for the rest of the trusses.

CHAPTER 9
TRAFFIC CONTROL

To ensure that vehicle drivers recognize and follow class and clearance restrictions, and that vehicles come upon the bridge properly, use traffic control measures.

BRIDGE SIGNS

Mark bridges and access roads with standard North Atlantic Treaty Organization (NATO) bridge and vehicle classification signs. These signs state the class, the roadway width, and the overhead clearance of the bridge. Details on the proper posting of NATO bridge signs are found in Field Manual 5-34.

BRIDGE GUIDES

Post traffic guides at each end of long bridges or at one end of short bridges. The guides' duties are to—

- Enforce traffic restrictions and bar unsafe vehicles. The guide determines the proper crossings of critical vehicles and bars all vehicles having vehicle class numbers exceeding the posted bridge class. The guide permits caution and risk crossings only when so authorized and in the presence of higher authority. (This higher authority must have theater or area approval of caution and risk crossings.)
- Keep traffic moving to avoid congestion. To avoid congestion, waiting vehicles are directed to park off the road.
- Stop traffic when bridge is damaged.
- Keep vehicles spaced properly and within speed limits specified for the type of crossing authorized.
- Help drivers of wide vehicles by giving instructions and signal guidance across the bridge.
- Maintain markers in a clean and easily recognizable condition. This is particularly necessary for the luminous painted panel verticals and roadway centerline when these are used.
- Arrange for alternative flow of traffic when needed to keep the bridge exit clear.

Approach guides are stationed on approach roads or at the intersection of an approach road with the main traffic net. They control the traffic on the approach roads. Normally, units other than the bridge crew provide the approach guides.

The two guides on long bridges should communicate by telephone. The guides at the bridge and the guides on the approach roads should also be able to communicate directly.

BRIDGE MARKING

Luminous tape for distinguishing the bridge during blackout conditions is provided with the bridge set. The tape is attached to the approach posts and is not visible from the air. These markers help guide drivers to and through the bridge and help to keep traffic moving steadily. They may be arranged on the bridge and at the approaches in different ways, according to the type of approach, length of the bridge, and amount of skylight. Figure 9-1 shows a suggested arrangement of blackout markers on the approach and on the bridge. On the bridge, place tape level with the top of the bottom story.

As a further aid in night driving and particularly as a guide for very wide vehicles, a 4-inch (10.1 centimeters) wide centerline in the roadway should be painted with luminous or white paint. Ribbands, end posts, panel verticals, panel chords, and gusset plates may also be painted with luminous or white paint. These painted markings aid in guiding wide vehicles in the daytime as well as all night traffic (Figure 9-2). Since luminous paint might be seen from the air, use it only when and where the tactical situation permits its use.

ROAD SURFACE

To avoid shocks and possible displacement of the bridge from the impact of vehicles striking its end, build up the road surface to about an inch (2.5 centimeters) above the decking of the ramp.

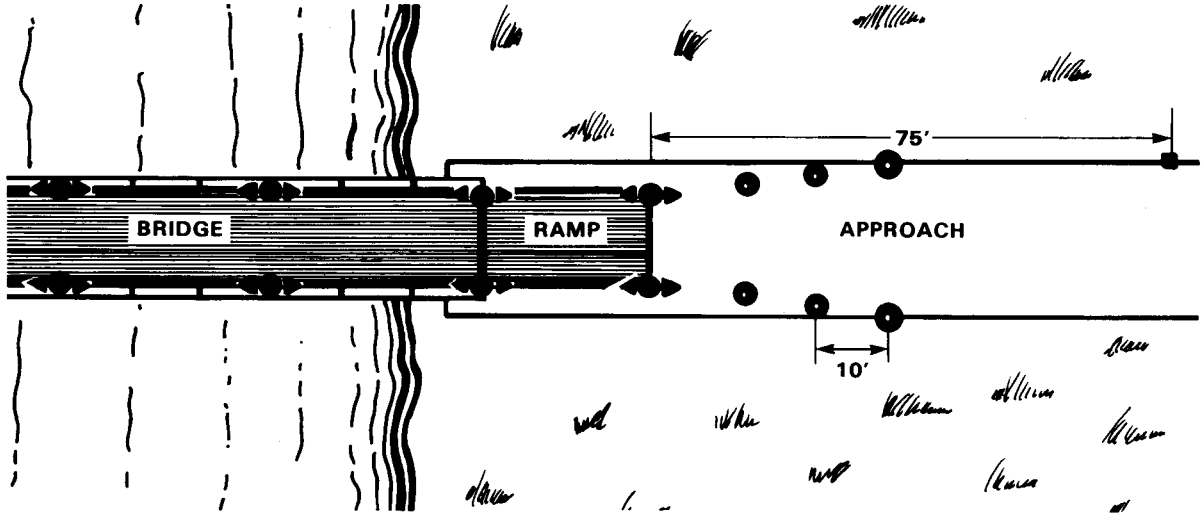


Figure 9-1 ***Arrangement of luminous markers on approach and on bridge***

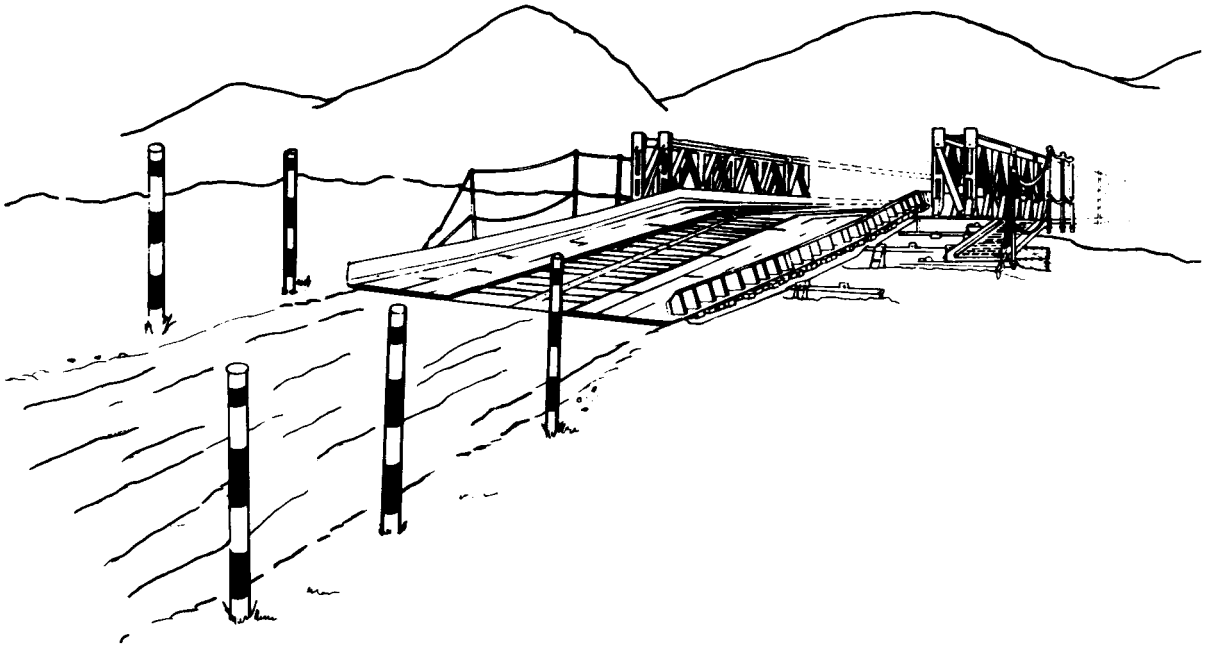


Figure 9-2 ***Bridge with painted centerline and panel posts to aid in night driving***

CHAPTER 10

TWO-LANE THROUGH-TYPE BRIDGE

The two-lane through-type panel bridge is used to provide two-way traffic where bridge supports at a demolished bridge are too narrow for two separate bridges (Figure 10-1). This type of bridge is also useful where a narrow launching site necessitates lateral movement of separately launched bridges to position them on their bearings. In this case, it would be easier to build a two-lane bridge.

DESCRIPTION

The bridge consists of two independent outer girders and a common middle girder, assembled from standard panel-bridge parts. The middle girder carries about half the total load and must be about twice as strong as the outer girders. Transoms overlap and occupy alternate transom seatings on the middle girder. Only the types of construction shown in Figures 10-2 to 10-7 (pages 116 and 117) and listed in Table 10-1 are used. Table 10-2 gives maximum spans that can be assembled and launched with standard equipment. Longer spans can be launched by using greased timbers or other expedients.

CLASS

The class and maximum spans of two-lane bridges are the same as those of single-lane bridges, with the same truss assembly as the outer girders (Table 10-3, page 118).

LIMITATIONS

Two-lane through-type bridges have the following limitations:

- The maximum span that can be launched by standard launching methods is 160 feet.
- Launching and jacking down are more difficult than for a single-lane bridge.

NUMBER OF PARTS AND SPARES

Formulas for computing the number of parts and spares required to assemble the bridge and nose are given in Table A-8, Appendix A. The percentage of spares used for single-lane bridges is also used for two-lane bridges.

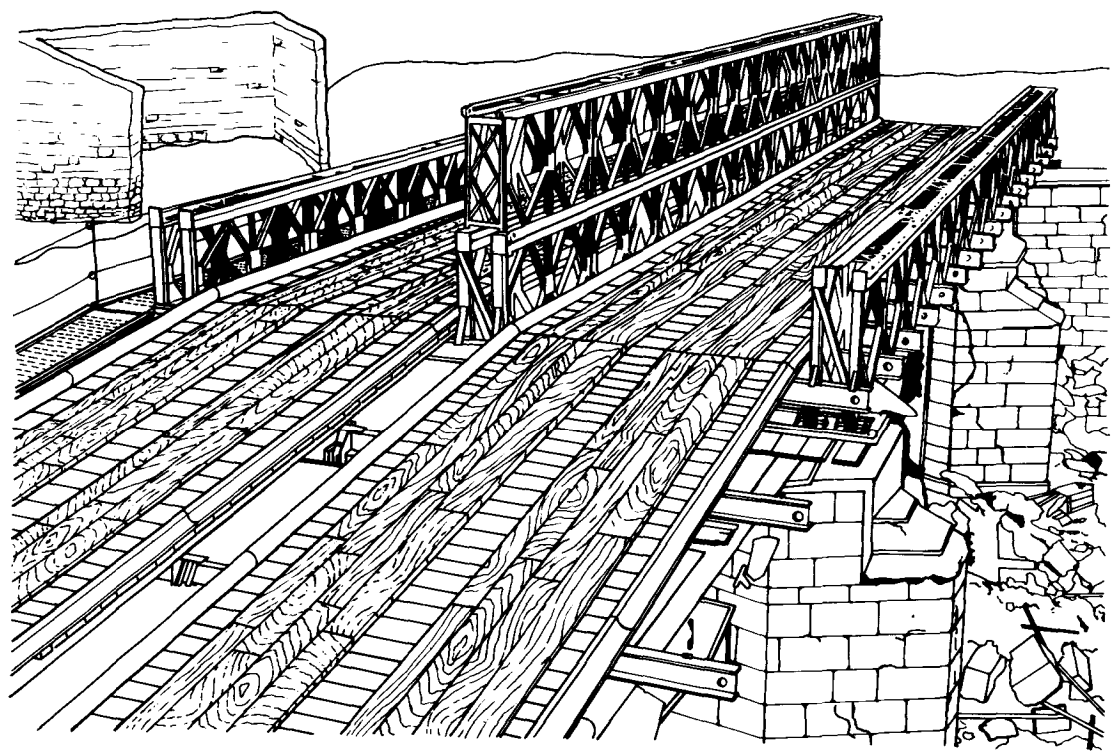


Figure 10-1 ***Two-lane panel bridge over demolished masonry arch bridge***

Table 10-1 ***Abbreviations for two-lane panel bridges, Bailey type M2***

TYPE OF CONSTRUCTION				
OUTER GIRDER		MIDDLE GIRDER		ABBREVIATION
TRUSS	STORY	TRUSS	STORY	
BRIDGE				
Single	Single	Double	Single	SS-DS
Double	Single	Double	Double	DS-DD
Triple	Single	Triple	Double	TS-TD
Triple	Single	Quadruple	Double	TS-QD
Double	Double	Quadruple	Double	DD-QD
Double	Triple	Quadruple	Triple	DT-QT[1]
NOSE				
Single	Single	Single	Single	SS-SS
Single	Single	Double	Single	SS-DS
Double	Single	Quadruple	Single	DS-QS

[1]Launched as double-story bridge

Table 10-2 ***Maximum span and weight per bay of two-lane panel bridges***

	TYPE OF CONSTRUCTION	MAXIMUM SPAN1 (ft)	OVERALL WIDTH	WEIGHT PER BAY2 (tons)
BRIDGE	SS-DS		36'3"	5.5
	DS-DD		36'3"	6.8
	TS-TD	120	36'11½"	8.0
	TS-QD	140	38'5½"	8.7
	DD-QD	160	38'5½"	9.3
	DT-QT[3]	160	38'5½"	12.9
NOSE	SS-SS			1.6
	SS-DS			2.0
	DS-QS			3.3

[1]Limited by launching weight on rocking rollers
[2]Fully decked and without footwalk and wear treads; Add 0.17 ton and 0.7 ton per bay for footwalks and wear treads respectively
[3]Launched as double-story bridge

ASSEMBLY DETAILS

The assembly of two-lane bridges differs from single-lane assembly in several ways. The first of these concerns transom seating in *triple-single/triple-double* bridges. The spacing of trusses in the girders of this bridge is normal with respect to one lane. With respect to the other lane, however, the two middle-girder trusses nearest that lane are spaced at 8 1/2 inches (20.8 centimeters) instead of 1 foot 6 inches (44.1 centimeters). Accordingly, transoms from that lane do not fit on seating pintles of the center truss; these pintles must be removed or transoms drilled (Figure 10-8, page 119).

Ramp clearance also differs. To provide clearance between transoms and ramps at the ends of *single-single/double-single* and *double-single/double-double* bridges, cut a 3 1/2- by 4 1/2-inch (86 by 11 centimeters) notch in transoms seated on the end posts and offset the ramp transoms 2 1/4 inches (5.5 centimeters) from the bridge centerline (Figure 10-9, page 120).

The number of bays and assembly of launching noses is determined as follows:

- For *single -single/double-single* and *double-single/ double-double* bridges, noses consist of three *single-single* trusses. Assemble one completely braced nose of the required length for one lane. For the second lane, add a single truss and connect it to the middle truss by transoms overlapping the transoms of the first lane. Add rakers to the second lane, but omit sway bracing (Figure 10-10, page 121).
- For *triple- single/triple-double, triple-single/quadruple-double,* and *double-double/quadruple-double* bridges, noses normally consist of *single-single* outer girders and two *single-single* middle girders (Figure 10-11, page 121). However, all girders in the last two nose bays of the 140-foot (43 meters) *double-double/ quadruple-double* and the last three nose bays of the 150- (46.2 meters) and 160-foot (49.2 meters) *double-double/quadruple-double* bridges are double-truss assembly. In all cases, place transoms in alternate seatings and brace the nose the same as for normal assembly. Transoms connect the nose girders of the *triple-single/triple-double* bridge. However, the nose girders of the *triple-single/quadruple-double* and *double-double/quadruple-double* bridges cannot be connected because transoms are not long enough except in *double-single/quadruple-single* nose bays.

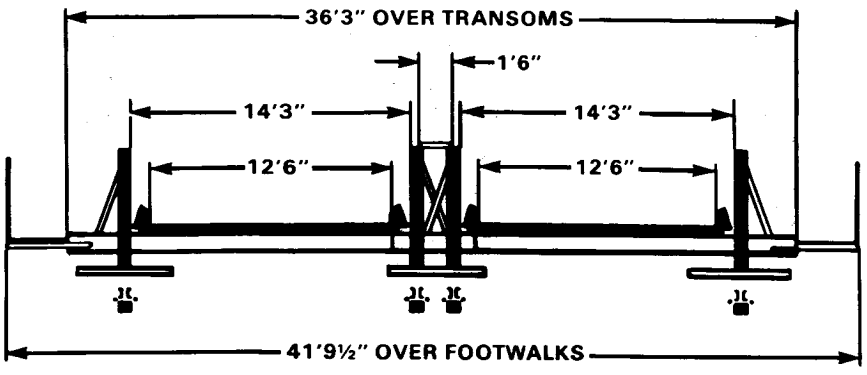


Figure 10-2 SS-DS ***two-lane bridge***

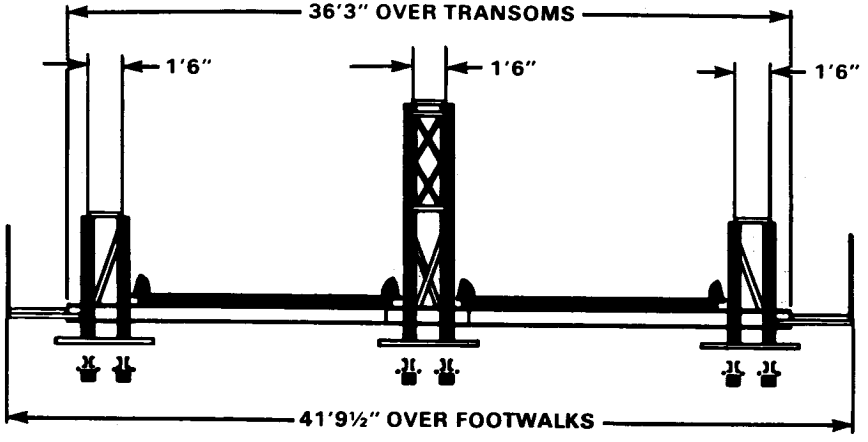


Figure 10-3 DS-DD ***two-lane bridge***

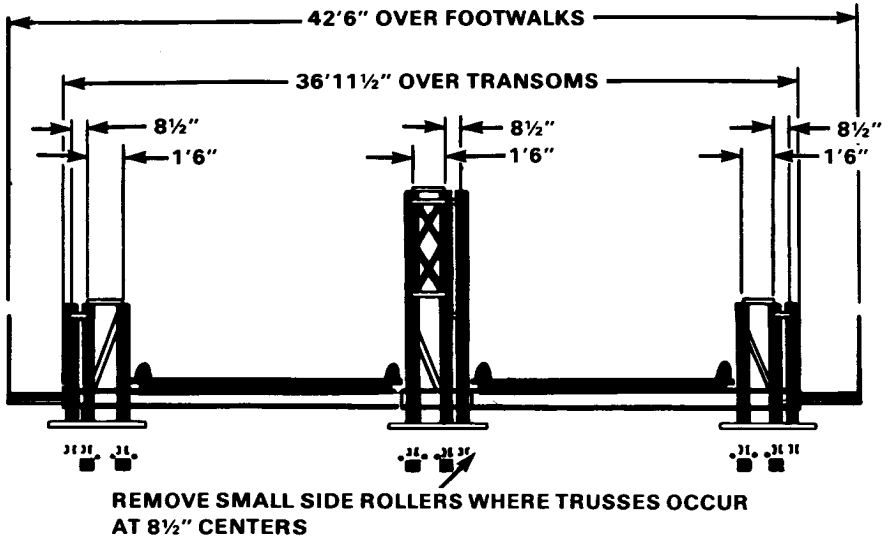


Figure 10-4 TS-TD ***two-lane bridge***

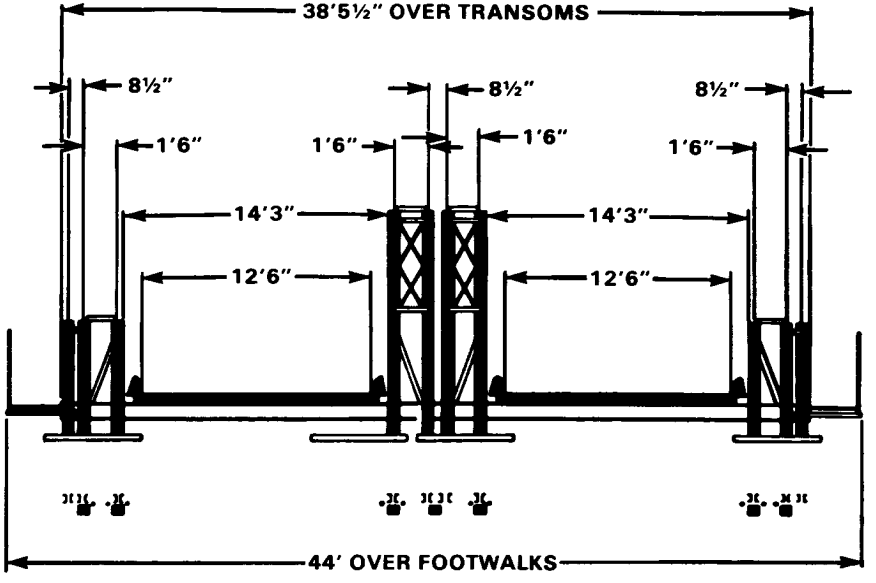


Figure 10-5 TS-QD ***two-lane bridge***

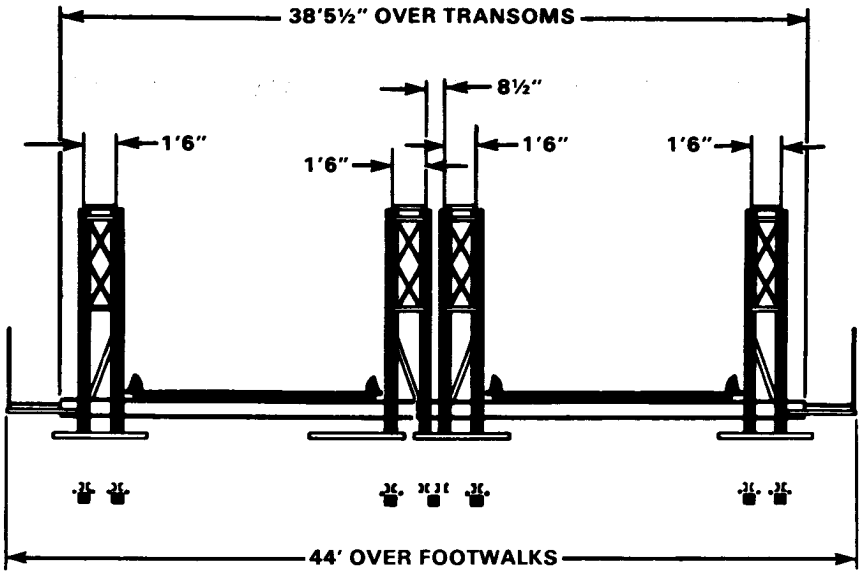


Figure 10-6 DD-QD ***two-lane bridge***

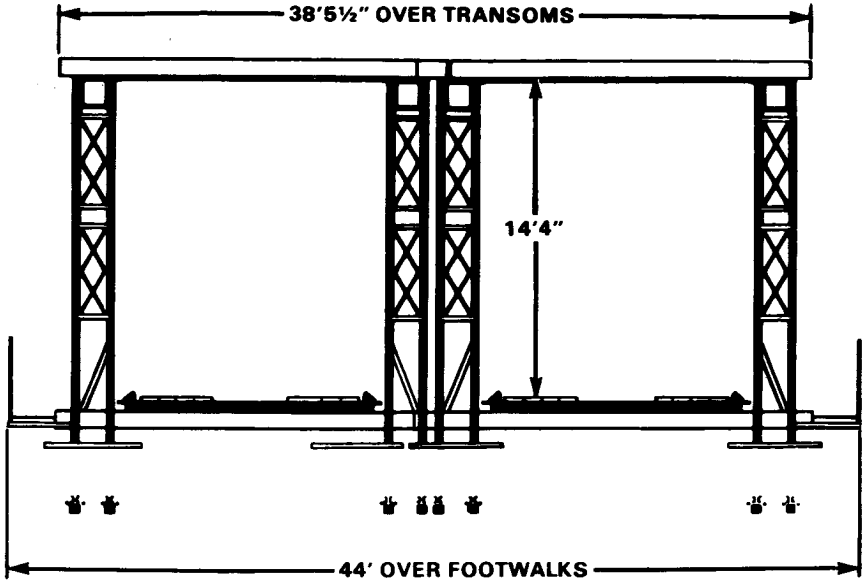


Figure 10-7 DT-QT ***two-lane bridge***

Table 10-3 ***Class and launching data for two-lane bridges***

	SPAN (ft)		30	40	50	60	70	80	90	100	110	120	130	140	150	160
SS-DS	Class	W	30	24	24	20	20	16								
		T	30													
	Launching wt (tons)		21	28	33	41	48	53								
	Sag (in)		4	5	7	10	14	18								
	Bays in nose SS-SS		2	3	3	4	5	5								
DS-DD	Class	W				65	60	50	40	30	20	16				
		T				65	60	55	45	30						
	Launching wt (tons)					48	55	64	72	79	87	96				
	Sag (in)					7	9	14	20	23	33	45				
	Bays in nose SS-SS					4	4	5	6	6	7	8				
TS-TD	Class	W							65	50	35	30	20	16		
		T							65	55	40	35				
	Launching wt (tons)								85	93	103	111	121	131		
	Sag (in)								19	22	30	34	47	62		
	Bays in nose SS-DS								6	6	7	7	8	9		
TS-QD	Class	W							65	50	35	30	20	16		
		T							65	55	40	35				
	Launching wt (tons)								91	100	111	119	130	141		
	Sag (in)								19	22	30	34	47	62		
	Bays in nose SS-DS								6	6	7	7	8	9		
DD-QD	Class	W									65	45	35	30	24	16
		T									70	55	45	35		
	Launching wt (tons)										118	127	138	152	163	152
	Sag (in)										22	24	31	38	41	45
	Bays in nose SS-DS										7	7	8	7	6	7
	DS-QS													2	3	3
DT-QT	Class	W												70	60	55
		T												70	60	55

Note:
W represents wheeled-load class
T represents tracked-load class

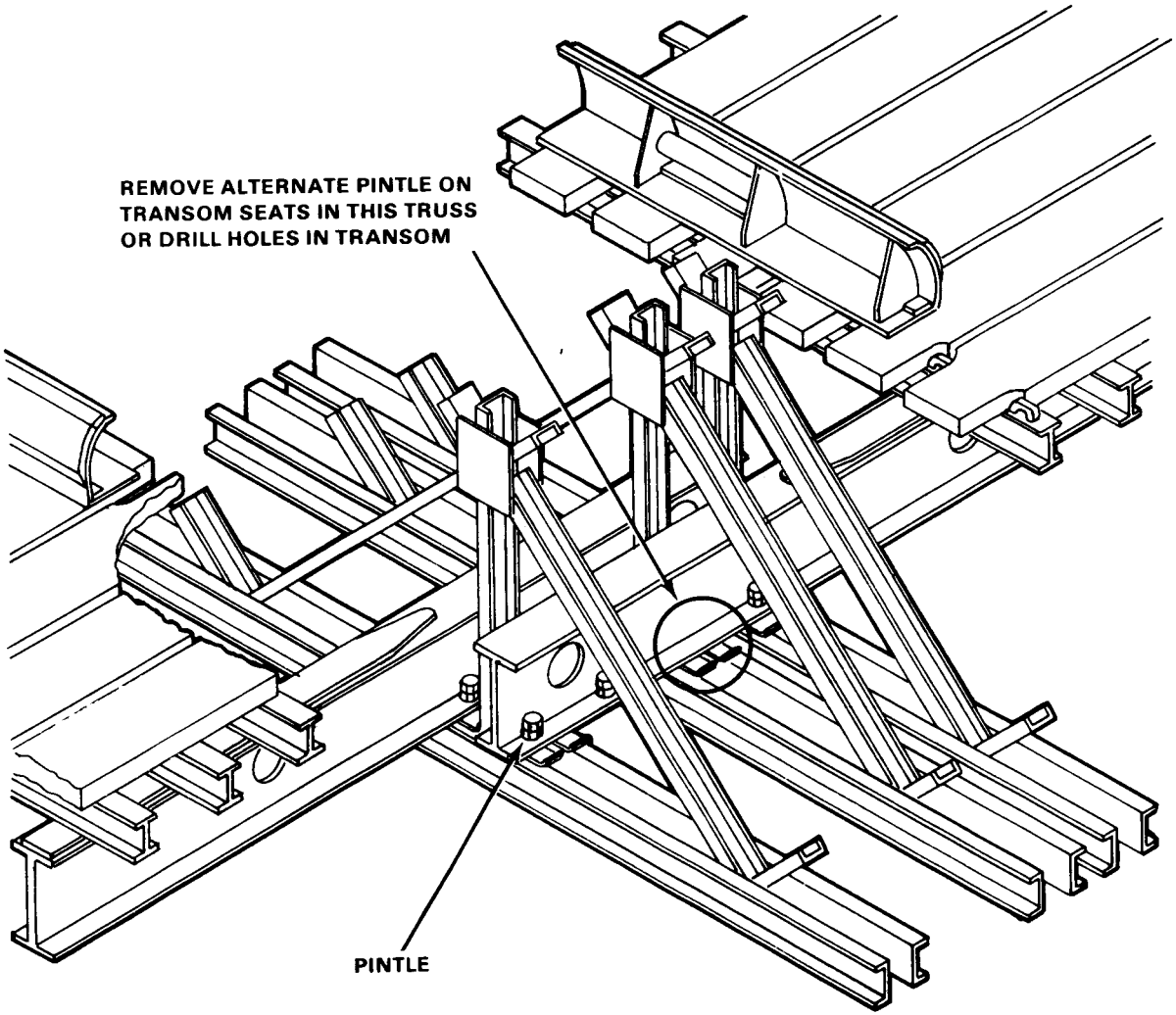


Figure 10-8 ***Transom seating in TS-TD bridges***

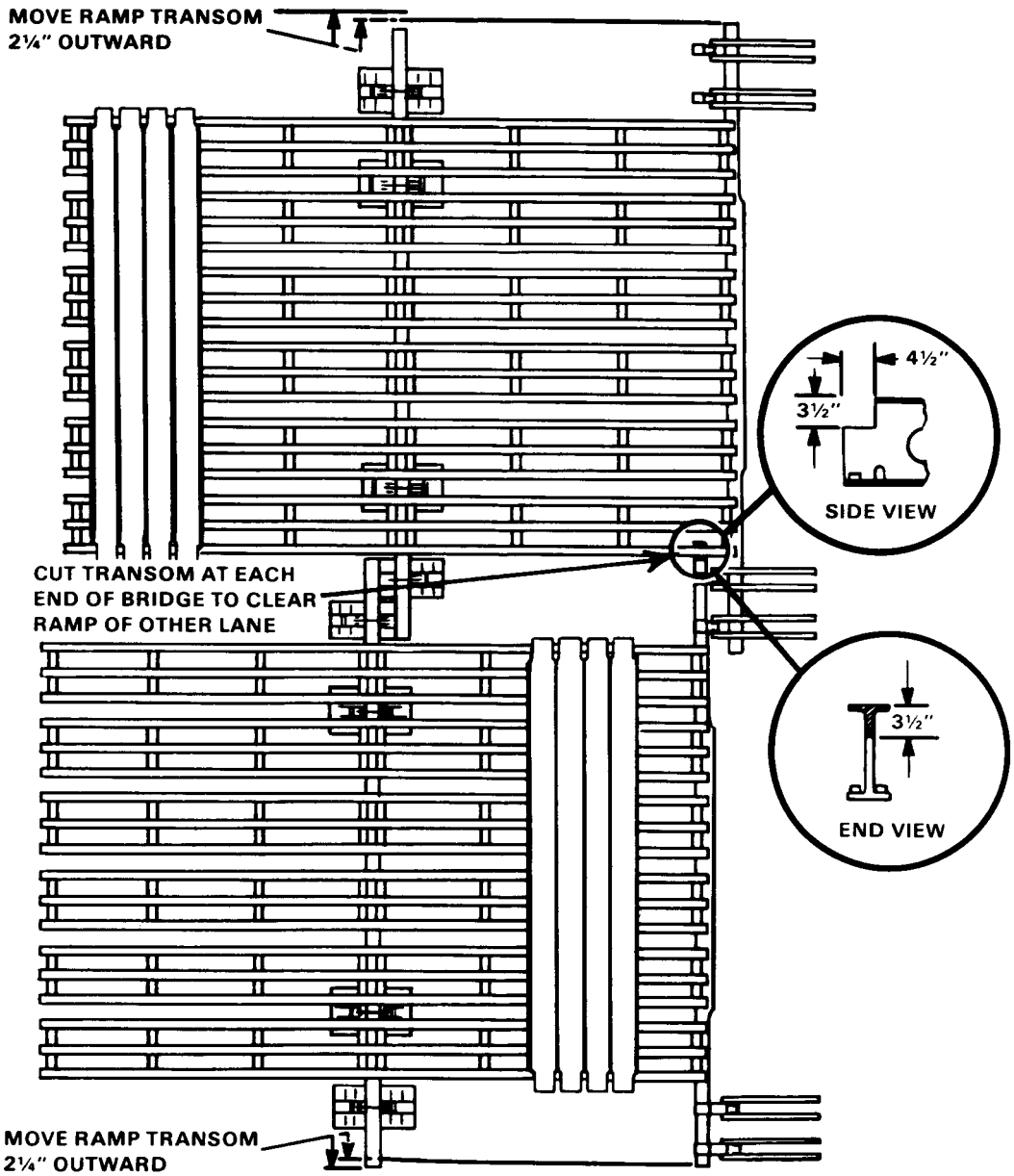


Figure 10-9 ***Ramp clearance for SS-DS and DS-DD bridges***

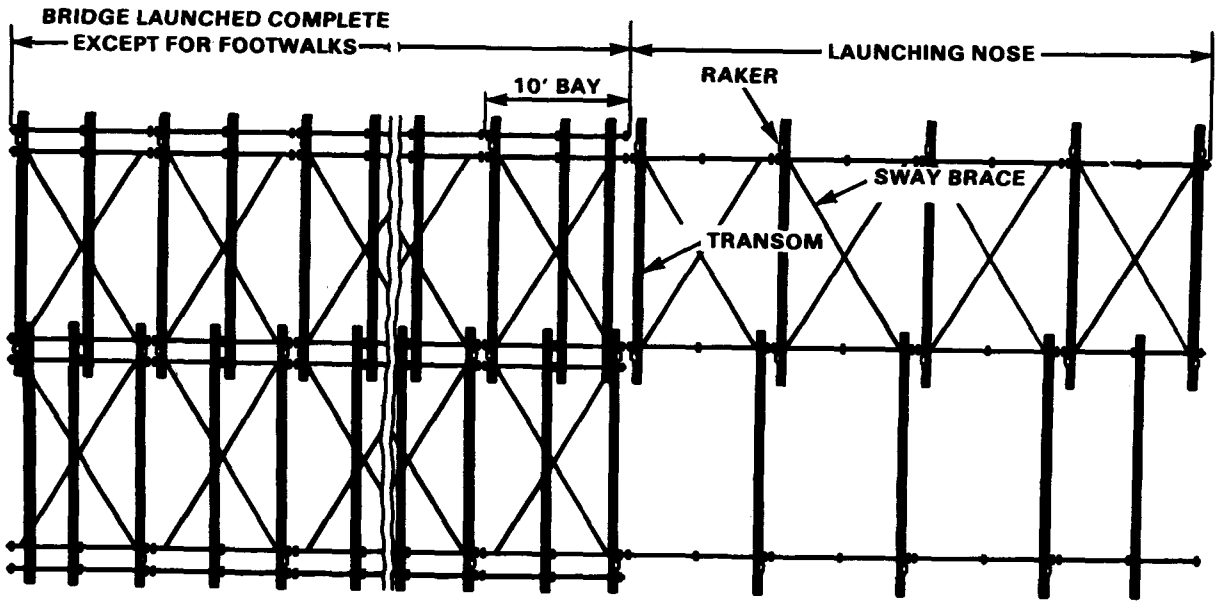


Figure 10-10 ***Overhead view of typical launching nose for SS-DS and DS-DD bridges***

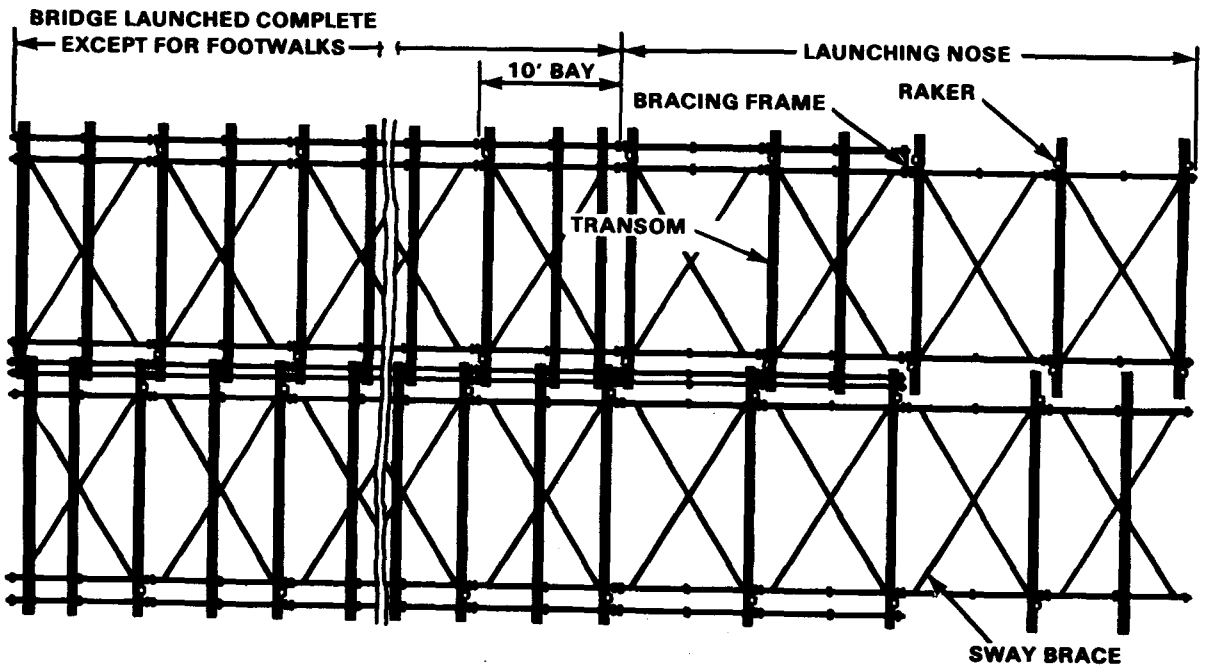


Figure 10-11 ***Overhead view of typical launching nose for 140-, 150-, and 160-foot DD-QD bridges***

WORKING PARTIES AND ASSEMBLY TIME

With the same party organization as for a single-lane bridge, assembly time for a two-lane bridge is slightly more than twice as long. With a specially organized crew (Table 10-4), assembly time for a two-lane bridge is slightly less than twice the assembly time for a single-lane bridge. Unloading and security details are the same as for a single-lane bridge.

ROLLER LAYOUT

Figures 10-2 to 10-7 show lateral spacing of rocking rollers for various types of bridge assembly. Roller loads for outer girders are the same as for single-lane bridges. However, since roller loads for the middle girder are about double, use enough plain rollers under this girder to prevent overloading them. These plain rollers must be staggered to provide clearance between them (Figure 10-12). Chapter 5 describes the method of using a transom to position bearings for rocking rollers. Rocking rollers are used on the far bank for all bridges except *single-single/double-single,* where plain rollers may be used.

ASSEMBLY AND LAUNCHING

Methods of assembling and launching the two-lane bridge are the same for both the single-lane assembly party and the organization given in Table 10-4.

Table 10-4 Suggested organization of assembly parties for two-lane bridges

PARTY	TYPE OF CONSTRUCTION									
	SS-DS		DS-DD		TS-TD		TS-QD		DD-DQ	
	NCO	EM	NCO	EM	NCO	EM	NCO	EM	NCO	EM
PANEL	2	28	2	28	2	48	2	54	3	64
Carry		**24**		**24**		**42**		**48**		**56**
Pin		**4**		**4**		**6**		**6**		**8**
Transcom										
Carry		**16**		**16**		**16**		**16**		**16**
Clamp		**2**		**2**		**4**		**4**		**4**
Bracing	2	18	2	18	2	20	2	20	2	20
Sway-brace		**6**		**6**		**6**		**6**		**6**
Raker		**6**		**6**		**6**		**6**		**6**
Bracing-frame		**2**		**4**		**4**		**8**		**10**
Chord-bolt				**2**		**2**		**4**		**6**
Tie-plate						**3**		**2**		
Decking	2		2		2		2		2	
Stringer		**12**		**12**		**12**		**12**		**12**
Chess-and-ribband		**8**		**8**		**8**		**8**		**8**
Total	**8**	**80**	**8**	**84**	**8**	**109**	**8**	**120**	**9**	**132**

Assembling

Assemble a *single-single/double-single,* and *double-single/double-double bridge* as follows:

1. Assemble one lane of launching nose with sway bracing in every bay, using launching links if necessary. Place one transom behind forward upright of panel in first bay and one transom on front of rear upright of panel at each joint. Fix rakers at each joint.
2. Add third truss for other lane, using launching links if necessary.
3. Place one transom of panel in first bay and one transom behind upright of panel at each joint. Fix rakers at each joint.
4. Assemble bridge the same as for single-lane bridge assembly, keeping panels in one lane one bay ahead of panels in the other lane. Attach all bracing frames as for a single-lane bridge.

Assemble a *triple-single/triple-double,* a *triple-single/quadruple-double,* and a *double-double/quadruple-double* bridge the same as for single-lane assembly, keeping panels in one lane one bay ahead of panels in other lane. For double- and triple-truss middle girders, attach bracing frames, tie plates, and rakers as in single-lane bridge assembly. When middle girder is quadruple-truss assembly, do not use tie plates between center trusses; use full number of bracing frames and rakers (Figures 10-2 to 10-7).

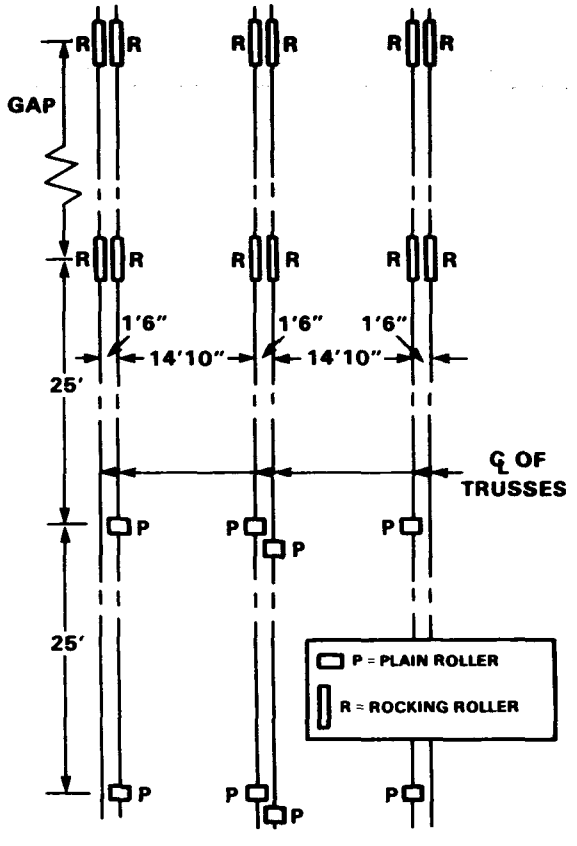


Figure 10-12 ***Typical roller layout showing plain rollers staggered under middle girder***

Assemble a *double-triple/quadruple-triple* bridge the same as a *double-double/quadruple-double* bridge. However, when using overhead bracing supports in both lanes, make sure female panel lugs in one lane face in opposite direction to female lugs in other lane. This prevents interference between overlapping transoms.

Launching

Table 10-3 gives the launching weight for each type of assembly. The lighter bridges listed in the table can be launched by single-lane launching methods. For heavier bridges, use vehicles with winches to aid in launching. To keep the balance point of bridge and nose behind the near-shore rocking rollers, be careful not to overload rollers. Spans longer than those listed in Table 10-2 can be launched by—

- Skidding the bridge over greased timbers to give more bearing along the lower chord of the girders. The bridge load, however, must not exceed the crushing strength of the timber.
- Launching the bridge in skeleton form so the allowable load on the rollers is not exceeded.
- Using a special rocking distributing beam for mounting two rocking rollers in line under each truss.

Jacking

Jacking of a single-span two-lane bridge is done the same as for a single-lane bridge. For jacking bridges on piers, see Chapter 16. Table 10-5 (page 124) gives maximum lengths of adjacent spans of continuous-span two-lane bridges that can be jacked over intermediate piers with jacks arranged as shown in Figures 16-18 and 16-19.

REINFORCED TWO-LANE BRIDGES

Two-lane bridges are reinforced by adding trusses or stones using the same methods as for single-lane bridges. Normally, reinforcement for only one lane is necessary. For capacity greater than class 70, the deck system must be reinforced by using four transoms per bay instead of two and by adding longitudinal wear treads. Table 10-6 (page 125) gives the truss asssembly of reinforced two-lane bridges. Stories can be added to the top of the existing girders or they can be underslung. However, when the middle girder is reinforced to triple-story, the panels must be underslung unless the reinforced outer girder is also triple-story; otherwise, overhead bracing cannot be installed.

Reinforcing one outer girder

One lane of a two-lane bridge can be reinforced by reinforcing one outer girder. However, the reinforced lane has the capacity of a single-lane bridge of the same assembly as the reinforced outer girder only when the normal lane is closed to traffic.

Reinforcing one outer girder and middle girder

When both the outer and middle girders are reinforced, the reinforced lane has the same capacity as a single-lane bridge of the same assembly, without closing the normal lane to traffic.

Table 10-5 ***Maximum length of continuous-span two-lane bridge that can be jacked over intermediate pier[1]***

TYPE OF CONSTRUCTION		SS-DS		DS-DD		TS-TD		TS-QD		DD-QD	
		SHORT	LONG	SHORT	LONG	SHORT	LONG	SHORT	LONG	SHORT	LONG
JACKS ARRANGED AS IN FIGURE 16-18	JACKS UNDER TRUSSES AT CENTER AND EACH SIDE OF BRIDGE — TWO	0-35 40-55 57.5	(2) 60 57.5	0-40 45-50 55-65	(2) 70 65						
	FOUR	0-45 50-80	(2) 80	0-70 75-120	(2) 120	0-70 75-85 90-100 105-110	(2) 120 115 110	0-60 65-80 85-95 97.5	(2) 105 100 97.5	0-65 70-85 90-100 102.5	(2) 110 105 102.5
JACKS ARRANGED AS IN FIGURE 16-19	SIX	0-45 50-80	(2) 80	0-60 65-80 85-95 97.5	(2) 105 100 97.5	0-50 55-65 70-80 82.5	(2) 90 85 82.5				
	TWELVE	0-45 50-80	(2) 80	0-70 75-120	(2) 120	0-80 85-140	(2) 140	0-70 75-85 90-100 105-115	(2) 125 120 115	0-75 80-90 95-105 110-120	(2) 130 125 120

[1]Based on dead weight of two spans of same construction over intermediate pier
[2]Length of long span cannot exceed 167 percent of short span

CONVERSION OF SINGLE-LANE BRIDGES TO TWO-LANE BRIDGES

A single-lane bridge can be converted to a two-lane bridge without closing the bridge to traffic for along period. If a two-lane bridge is to be centered on an old bridge centerline, proceed as follows

1 Remove approach ramps on each bank and jack bridge up. Lay transom on three plain rollers on each bank perpendicular to bridge centerline, so raker lugs come directly under space between girders of end bays. Add extra bays to the bridge where insufficient working space on bank is available, before placing transoms.

2 Prepare new bank seats and position grillage. The center grillage must be twice the width of the outer grillage.

3 Jack bridge down on the transoms resting on the rollers, and move bridge sideways to new position.

Note: Launching nose for *triple-single/triple-double, triple-single/quadruple-double,* and the remainder of *double-double/quadruple-double* bridges is similar, with extra transom and two bays of *double-single/quadruple-single* assembly omitted.

4 Position bearings for bridge in its new location. Bearings are placed under original end span or extra span, depending on bank conditions. Jack bridge onto bearings.

5 Place ramps and open single lane of bridge to traffic (Figure 10-13).

6 Position rollers for third girder and launch by single-girder method (Figure 10-13). See Chapter 19 for launching by single girders. The third girder can also be launched by using a truck crane on deck of existing bridge.

Table 10-6 ***Equivalent simple-span assembly for reinforced lane of a two-lane bridge***

EXISTING BRIDGE	METHOD OF REINFORCING		EQUIVALENT REINFORCED LANE CONSTRUCTION	
	OUTER GIRDER	MIDDLE GIRDER	NORMAL LANE CLOSED TO TRAFFIC	BOTH LANES OPEN TO TRAFFIC
SS-DS	Add one truss		DS	SS
	Add one truss	Add double-truss second story	DS	DS
DS-DD	Add double-truss second story		DD	DS
	Add double-truss second story	Undersling double-truss third story	DD	DD
TS-TD	Add triple-truss second story	Undersling triple-truss third story	TD	TS
	Add triple-truss second story	Undersling triple-truss third story	TD	TD
TS-QD	Add double-truss second story		DD	DD
	Add double-truss second and third stories and overhead bracing	Add double-truss third story and overhead bracing	DT	DT
DD-QD	Add double-truss third story and overhead bracing	Add double-truss third story and overhead bracing	DT	DT

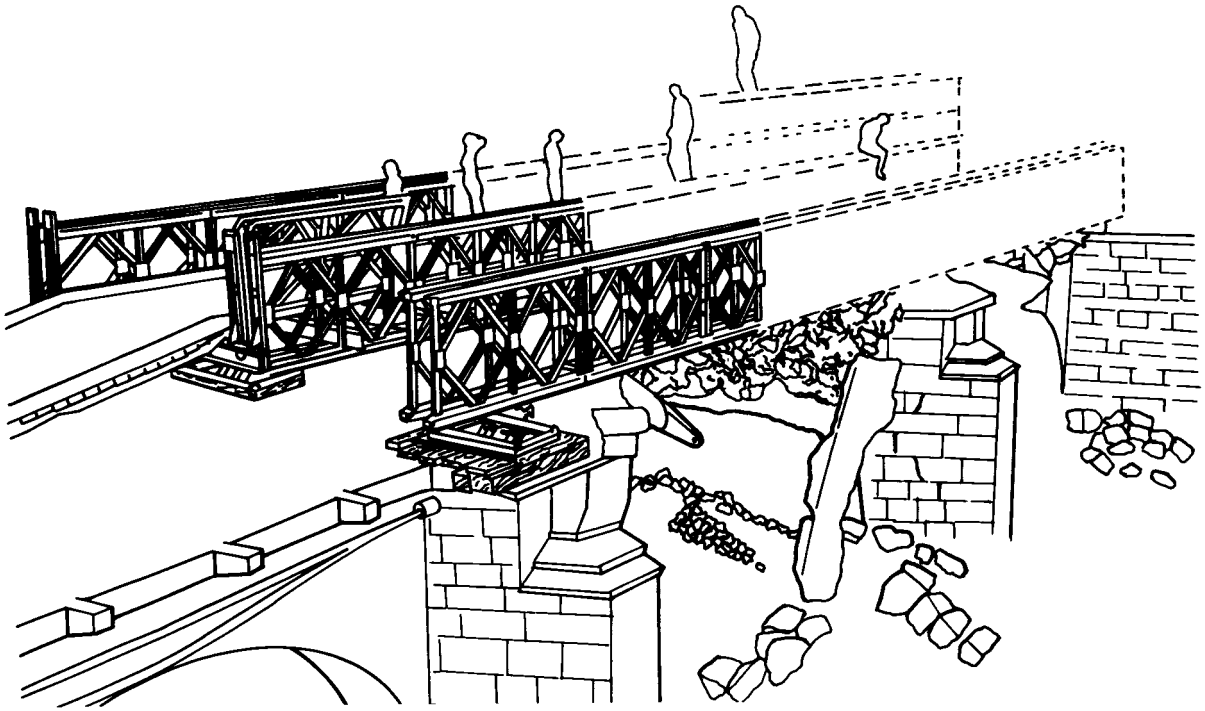


Figure 10-13 ***Converting single-lane bridge to two-lane bridge,*** *using single-girder method for launching outer girder in second lane*

7 Connect third girder to rest of bridge with transoms. If available, use a truck crane to place transoms. If a truck crane is not available or if sag is great, add second story to middle girder before connecting third girder with transoms.

8 Add second story to middle girder.

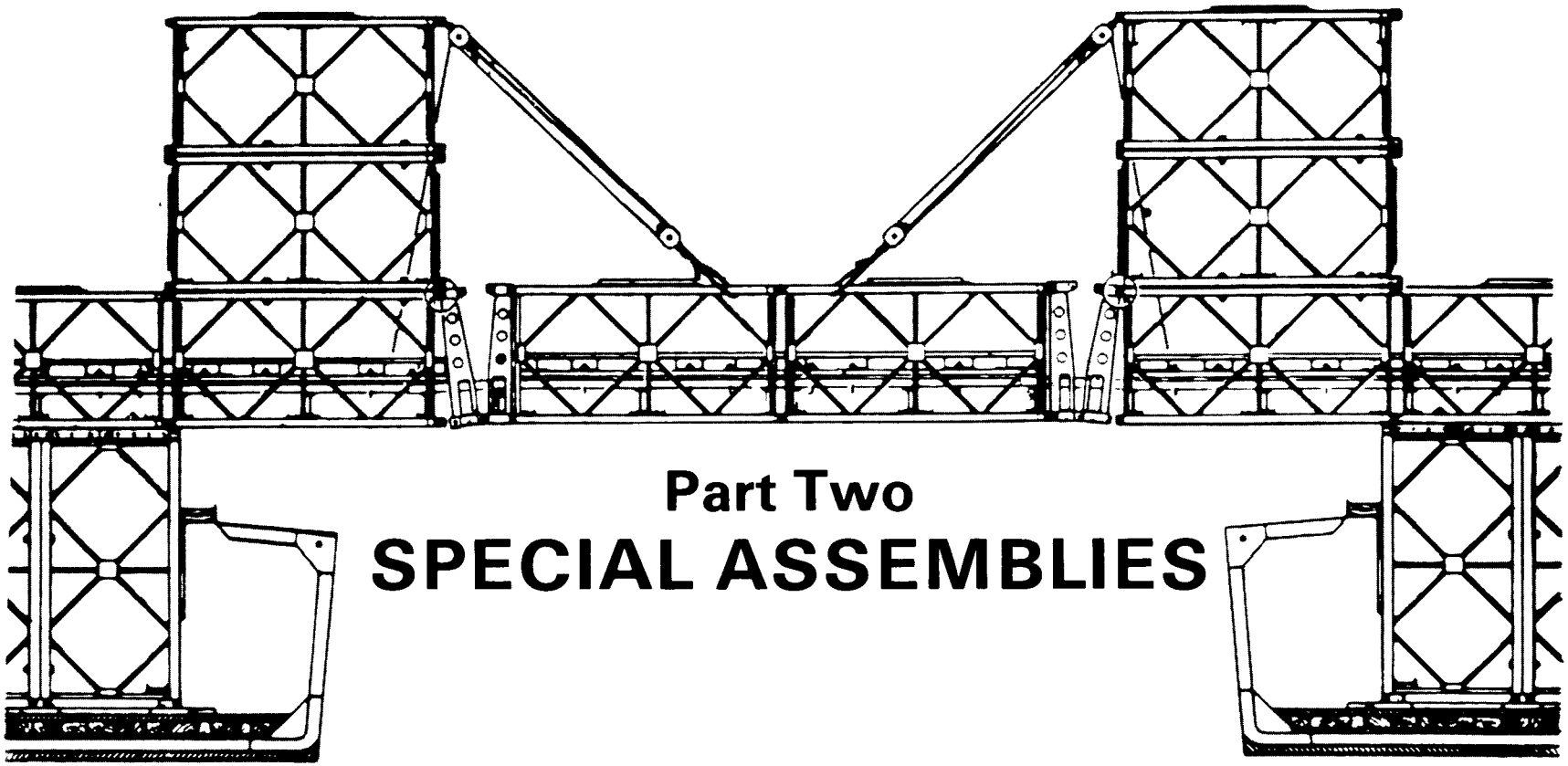
9 Deck second lane.

If the existing bridge is to remain in position, proceed as follows:

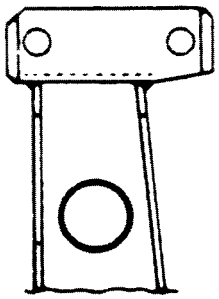
1 Jack bridge up and double grillage area under center girder. Jack bridge down. If bridge is to be lengthened, add extra bays and locate bearings and grillage in new position.

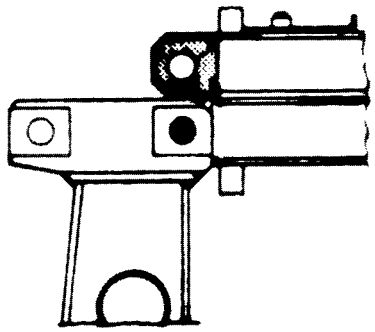
2 Proceed as for two-lane bridge.

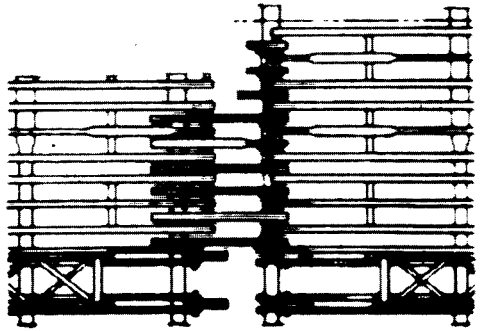
Note: Single lane is open to traffic during construction.



Part Two
SPECIAL ASSEMBLIES







CHAPTER 11

EXTRA-WIDENED BAILEY BRIDGE M3

COMPONENT PARTS 130
ASSEMBLY AND LAUNCHING OF SINGLE-STORY BRIDGES 132
ASSEMBLY AND LAUNCHING OF DOUBLE-STORY BRIDGES 135
ASSEMBLY AND LAUNCHING OF TRIPLE-STORY BRIDGES 136
GRILLAGES AND RAMP SUPPORTS 136

The introduction of wider vehicles prompted the development of the extra-widened Bailey bridge M3. The US Army does not stock the M3 Bailey bridge. It is a standard bridge in the United Kingdom. This bridge has a 13-foot 11¾-inch (4.3 meters) clear roadway and a clear distance between trusses of 15 feet 81/2 inches (4.8 meters), as shown in Figure 11-1. This added width requires certain new parts that are not contained in the M2 bridge set. The most important of these are a long transom, more stringers, long chess, sway braces, and bracing frames. The bridge normally is assembled for either class 30 or class 80 loads. The maximum spans for each type of assembly at these classes are given in Table 11-1. The weight, in short tons, per typical bay for each type of assembly, class, and span is given in Table 11-2.

Table 11-1 ***Maximum class of vehicle for safe crossing over extra-widened Bailey bridge M3***

BRIDGE CLASS	TYPE OF CONSTRUCTION	SS	DS	TS	DD	TD	DT	TT	TRANSOMS PER BAY
30	Max simple span (ft)	40	80	110	130	150	180	200	2
	Max wheeled-vehicle class	22*	31	30	30	30	32	31	
	Max tracked-vehicle class	23*	33	33	34	33	36	33	
80	Max simple span (ft)		40	60	80	110	110	120	2
	Max wheeled-vehicle class		70*	87*	95*	78	73*	93*	
	Max tracked-vehicle class		66*	80*	93*	80	75*	96*	4
									4

* Indicates shear governs; otherwise, moment governs

Table 11-2 ***Weight of typical bays, in short tons, for extra-widened Bailey bridge M3***

BRIDGE CLASS		TYPICAL BAYS	TYPE OF CONSTRUCTION SS	DS	TS	DD	TD	DT	TT
30	Two transoms per bay, weight per bay (short tons)	Tail	4.04	4.90	5.62	6.16	7.50	6.16	7.50
		Intermediate	3.45	4.09	4.72	5.35	6.58	7.18	9.02
		Head	4.73	5.57	6.33	6.86	8.22	6.91	8.27
80	Four transoms per bay, weight per bay (short tons)	Tail		6.01	6.76	7.27	8.63	7.27	8.63
		Intermediate		4.76	5.39	6.01	7.25	7.85	9.69
		Head		5.93	6.69	7.22	8.58	7.27	8.63

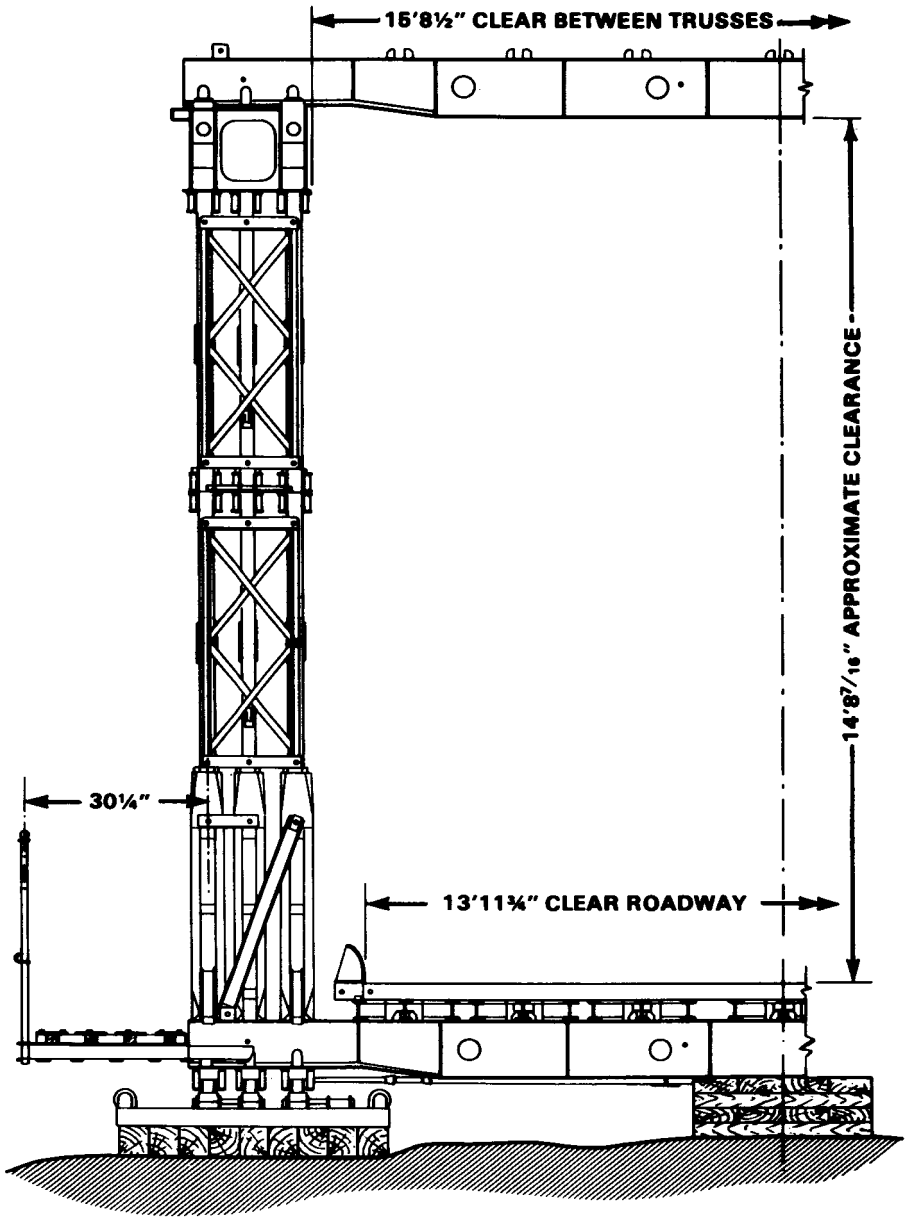


Figure 11-1 ***Cross section of extra-widened Bailey bridge M3***

COMPONENT PARTS

TRANSOM

The transom is a 12-inch (29.4 centimeters) I-beam, 19 feet 11 inches (6.1 meters) long, tapered at the ends to 10 inches (24.5 centimeters) as shown in Figure 11-2. Two transoms per bay are used for class 30 bridges and four transoms per bay are used for class 80.

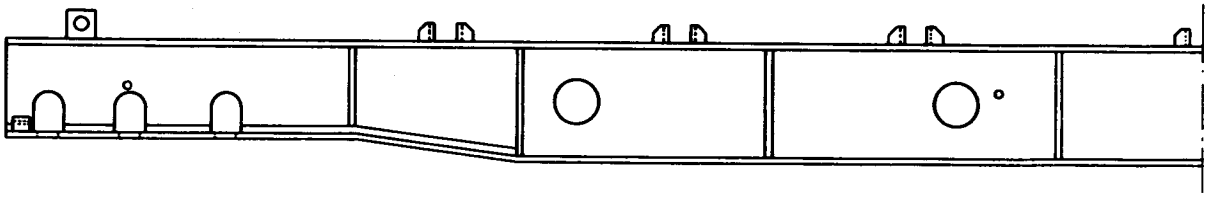


Figure 11-2 Transom, M3

CHESS

The chess are 15 feet (4.6 meters) long, 8¾ inches (21.4 centimeters) wide, and 3 5/8 inches (8.9 centimeters) deep. Thirteen chess are required for each bay of the bridge except the head bay, which requires 14. The latter is for class 80 only.

STRINGERS

The plain and button stringers are the same as those used in the M2 bridge, except that the length of the head bay for class 80 bridges requires two long button stringers, M3, and two plain stringers, M3. These stringers are 10 feet 11½ inches (3.2 meters) long. They are used in the class 80 bridge only and not in the class 30 bridge.

TRANSOM CLAMP

The transom clamp is the same as that used in the M2 bridge except that the width across the top has been reduced slightly to prevent the arm from interfering with the vertical bracing frame used in the bottom story of triple-truss bridges.

RIBBANDS

The ribbands are the same as those in the M2 bridge, except that two long ribbands, M3, are required in the head bay of the class 80 bridge. These are 10 feet 11¼ inches (3.4 meters) long.

END POSTS

The male and female end posts are the same as those used in the M2 bridge except that in tripe-truss bridges the male end posts for the middle truss of both class 30 and class 80 bridges above the transom bracket removed. This permits rakers to be connected between the end posts on the inner trusses and the transom. Use female end posts, M3, only on the middle truss of the end bay of class 80 bridges.

HEADLESS PANEL PIN

Headless panel pins are used on triple-truss assembly to connect the end posts, M3, to the middle trusses. They enable the end posts to be fitted after the launching nose has been removed and allow damaged end posts to be replaced. These panel pins, M3, are similar to those in the M2 bridge except the head is removed (Figure 11-3).

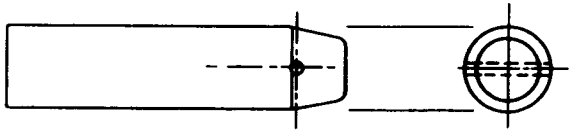


Figure 11-3 Headless panel pins, M3

RAKER

A new type of raker, M3, has been developed for use with the extra-widened Bailey bridge, M3. It is a 3-inch (7.4 centimeters) channel, 3 feet 8 5/16 inches (1.1 meters) long, as shown in Figure 11-4.

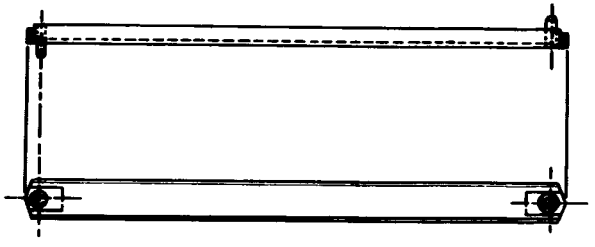


Figure 11-4 Raker, M3

RIBBLT BOLT

A ribband bolt, M3, is used as shown in Figure 11-5.

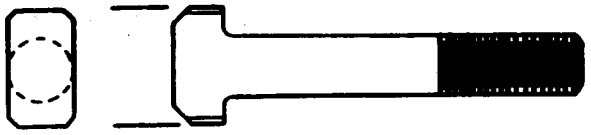


Figure 11-5 ***Ribband bolt, M3***

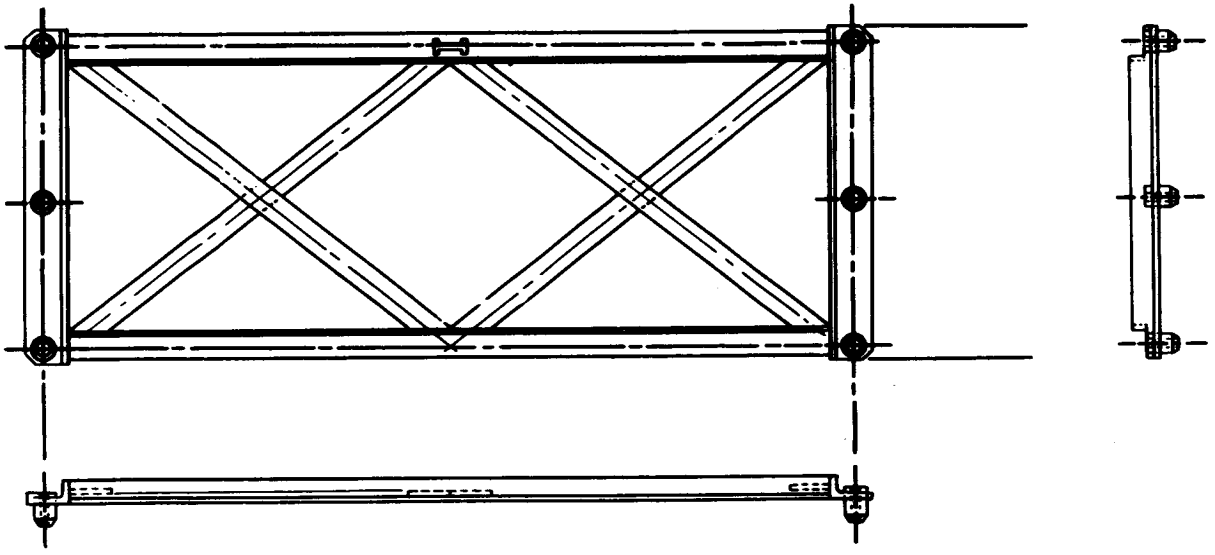


Figure 11-6 ***Bracing frame, M3***

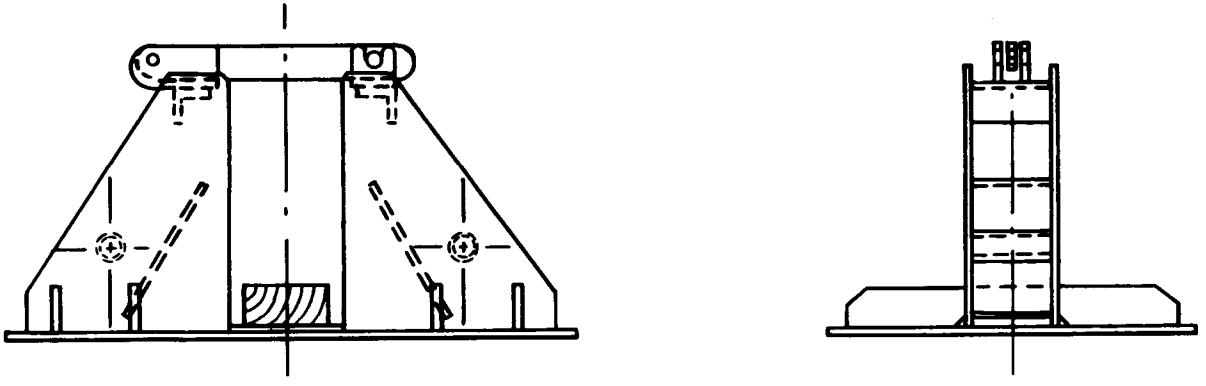


Figure 11-7 ***Ramp pedestal, M3***

BRACING FRAME

The bracing frame, M3, has an additional pair of dowels, as shown in Figure 11-6, to accommodate the bracing bolts connecting it to the middle truss of a triple-truss bridge.

SWAY BRACE

The sway brace, M3, is similar to that in the M2 bridge, but is 18 feet 1/8 inches (5.3 meters) between centers of eyes with the turnbuckle screwed tight.

OVERHEAD SWAY-BRACE EXTENSION

The overhead sway-brace extension has an eye at one end and a jaw at the other. It is connected to the sway brace, M3, for use in the overhead bracing of intermediate bays of triple-story bridges.

RAMP PEDESTAL

The ramp pedestal, M3, is used to support the deeper (12-inch) (29.4 centimeters) portion of the M3 transom. It is similar to the pedestal used in the M2 bridge, but is deeper and has a wider space for the transom (Figure 11-7).

ASSEMBLY AND LAUNCHING OF SINGLE-STORY BRIDGES

METHOD

The method of assembling and launching single-story M3 bridges is the same as that for the M2 bridge except for roller layout, launching nose, triple-truss assembly, and class 80 decking. The number of parts required per bay is given in Tables A-9 and A-10, Appendix A, for class 30 and class 80 bridges.

ROLLER LAYOUT

The lateral spacing of rollers is shown in Figure 11-8. The rollers must be staggered for triple-truss assembly. There is no suitable bridge part to use as a distance gage, and the roller templates must be positioned by means of steel tape or improvised gage.

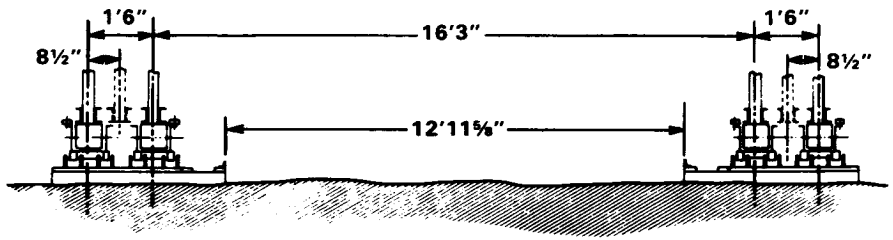
For 30- and 40-foot (9.2 and 12.3 meters) bridges, place a plain roller 15 feet (4.6 meters) from the rocking roller. On longer spans, space plain rollers at 27 feet (8.3 meters) and up, in increments of 25 feet (7.7 meters); consequently, the longitudinal spacing of plain rollers is normally at 27 feet (8.3 meters), 52 feet (23.3 meters), 77 feet (23.7 meters), and so forth.

LAUNCHING NOSE

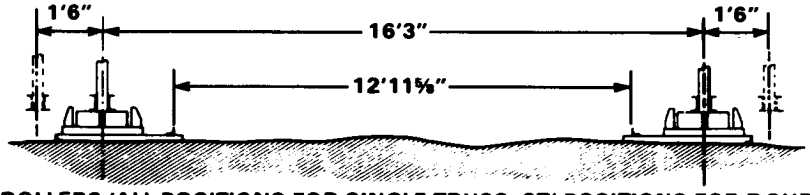
Information on launching weights and launching nose assemblies for various types of class 30 and class 80 bridges is given in Tables 11-3 and 11-4 (page 134).

Note the following:

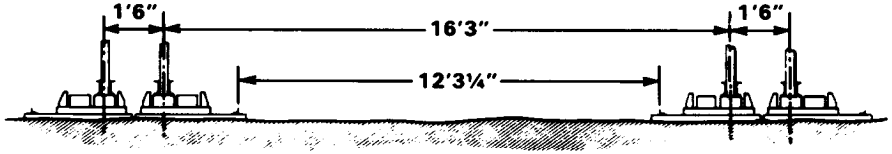
- The bridge is launched complete with decking and footwalks, except where shown.



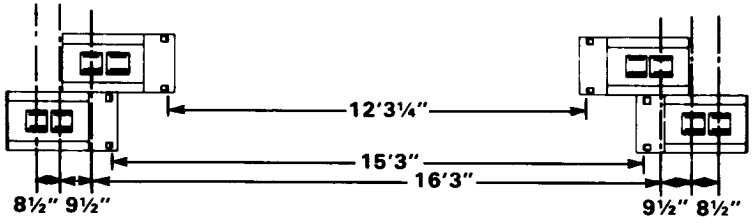
ROCKING ROLLERS (GUIDE ROLLERS REMOVED FOR TRIPLE TRUSS BRIDGE)



PLAIN ROLLERS (ALL POSITIONS FOR SINGLE TRUSS; 27' POSITIONS FOR DOUBLE TRUSS; 15' POSITIONS FOR 30')



PLAIN ROLLERS (52', 77', ETC. POSITION FOR DOUBLE TRUSS)



PLAIN ROLLERS (ALL POSITIONS FOR TRIPLE TRUSS)

Figure 11-8 ***Roller layout***

Table 11-3 ***Launching data for*** *class 30* ***spans***

SPAN (ft)	TYPE OF CONSTRUCTION	BAYS IN NOSE SS	BAYS IN NOSE DS	LAUNCHING WT (tons)	SAG (in)	d[1]	BRIDGE LAUNCHED WITHOUT:
30	SS	2		10.0	1½	19'6"	
40	SS	3		13.6	2½	26'11"	
50	SS	3		16.3	4	31'8"	
60	DS	4		23.4	5	37'8"	
70	DS	5		27.6	9	44'9"	
80	DS	5		30.9	13	49'6"	
90	TS	6		40.1	15	55'2"	
100	TS	7		44.9	20	61'11"	
110	TS	7		48.8	26	66'8"	
120	DS	7	1	60.6	21	72'6"	
130	DD	7	2	66.4	26	79'8"	
140	TD	6	3	81.7	26	81'7"	All footwalks and first four bays, chess and ribbands
150	TD	7	3	83.1	35	87'8"	All footwalks and first ten bays, chess and ribbands
160	DT[2]	7	4	80.9	36	99'4"	All footwalks, decking, and stringers
170	DT[2]	7	4	82.2	42	102'3"	All footwalks, decking, stringers, and first three bays in top story

[1]d is the distance from the center of gravity to the tail of the bridge
[2]Launched with overhead bracing and first and last bays double story only

- For the class 80 double- or triple-truss bridge, two rocking rollers are needed under each side, including the far bank for the launching nose.
- Use launching links not more than 40 feet behind the end of the *single-single* portion of the nose, and not more than 20 feet behind the end of the *double-single* portion of the nose.
- Due to the greater width of the bridge, set one transom with two rakers in each bay of the nose, and also set sway braces in each bay.

TRIPLE-SINGLE ASSEMBLY

After assembly of the skeleton launching nose, assemble the bridge trusses in echelon, with each outer truss always having one panel more than the adjacent truss. It is not possible to add a third truss to a double-truss bridge.

Assemble the first bay of the bridge as follows:

1 Connect the first two inner-truss panels to the inner trusses of the launching nose, driving the panel pins outward.

2 Place a transom through these panels in front of the center vertical, and connect the long arms of the sway braces to the front ends of the panels.

3 Assemble two panels for the middle trusses, and connect them to the transom clamps.

4 Assemble two panels for the outer trusses, and connect them to the transom clamps.

5 Pass a second transom through all three trusses of the first bay behind the front vertical, and a third transom in front of the rear vertical. Connect the panels to the transom with transom clamps.

6 Connect the short arms of the sway braces to the rear position, and fit bracing frames in the first bay on the top chords.

7 Fit bracing frames in front of the front verticals and behind the rear verticals. The front bracing frames are removed before the end posts are fitted.

8 Tighten transom clamps and sway braces. Place stringers and decking.

Assemble the second bay of the bridge as follows:

1 Place two panels for the outer trusses and connect them with pins driven inward. Drive outward all further pins on all trusses.

2 Place two panels for the outer trusses of the third bay, and connect them with pins driven outward.

3 Place two panels for the middle trusses in the second bay, using headless panel pins.

4 Connect two additional panels in bays four, three, and two, driving the panel pins outward.

5 Fit front end of sway brace in the second bay.

6 Pass a transom through all trusses in the second bay in front of the rear vertical, and another in front of the center vertical. Connect them with transom clamps.

7 Connect the sway braces to the rear positions.

8 Fit the bracing frames on the top chords, and behind the rear verticals of the second bay.

9 Tighten transom clamps and sway braces.

For subsequent bays, the sequence of assembly is similar to that described above. Make sure that each truss in each outer bay has one more panel than the truss in the next inner bay.

For decking, the placing of stringers and chess follows the same sequence as in the M2 bridge, except for the number of stringers in all bays, and the number of chess in the head bay.

*Table 11-4 **Launching data** for class 80 spans*

SPAN (ft)	TYPE OF CONSTRUCTION	BAYS IN NOSE SS	BAYS IN NOSE DS	LAUNCHING WT (tons)	SAG (in)	d[1]	BRIDGE LAUNCHED WITHOUT:
30	DS	2		13.5	1½	18'4"	
40	DS	3		18.3	2	25'2"	
50	DS	3		22.2	3½	30'11"	
50	TS	3		25.0	3½	29'4"	
60	TS	4		30.3	5	36'0"	
70	TS	5		35.7	6	42'7"	
70	DD	5		39.4	5½	41'10"	
80	DD	5		44.4	7	46'7"	
90	TD	5	1	60.8	9	52'2"	
100	TD	6	1	67.8	12	58'5"	
110	TD	6	1	73.9	14	63'3"	
110	DT[2]	5	2	77.0	12	63'4"	
120	TT[2]	5	3	83.2	15	69'0"	All footwalks, decking, stringers, and first two bays in top story.
130	TT	5	3	83.4	20	72'1"	All footwalks, decking, stringers, and first five bays in top story.

[1]d is the distance from the center of gravity to the tail of the bridge
[2]Launched with overhead bracing and first and last bays double story only

CLASS 80 DECKING

The *triple-single* assembly procedure just given is based on class 30 decking. For class 80 decking, the procedure is as follows:

1 Four transoms are required per bay. In both double- and triple-truss bridges, add the extra two transoms behind the center and front verticals.

2 Fit transom clamps alternately on the center vertical. For example, clamp the front transom to the panel in the second truss, and the rear transom to the panels in the first and third trusses.

3 Continue the stringers to the transoms on the end posts at each end. This makes the head bay of decking an n-foot bay. To do this, lay the first bay of stringers with two button stringers, M3, on the outside, then two plain stringers, M2, inside these, and two plain stringers, M3, inside again, and one plain stringer, M2, in the center. In the last bay use three plain stringers, M3. In all other bays use plain and button stringers, M2.

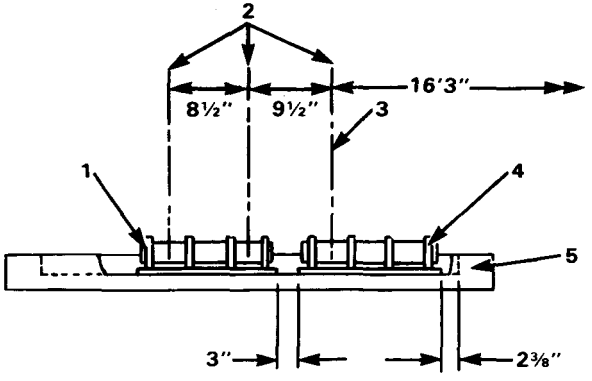


Figure 11-9 ***Position of bearings and base plates***

4 In the first bay use 14 chess and ribbands, M3. Use M2 ribbands and 13 chess in other bays.

END OF BRIDGE

Place the end posts, bearings, and base plates in the same way as the M2 bridge for single- and double-truss bridges. Make the following changes on triple-truss bridges:

- Place base plates as for double-truss bridges. The outer bearing carries the end posts of the second and third trusses on the two seatings each side of the center seating. The inner bearing carries the end post of the inner truss on its outer seating, as shown in Figure 11-9.
- Fit end posts, M3, to each end of the second truss, using headless panel pins.
- Fit rakers on inner end posts, and tie plates between end posts on second truss. It is not possible in the class 30 bridge to fit rakers at the tail end of the bridge because there is no transom on the end posts.

ASSEMBLY AND LAUNCHING OF DOUBLE-STORY BRIDGES

METHOD

The method of assembling and launching a double-story M3 bridge is the same as that for the M2 bridge, except for a few differences and the need to assemble the lower story.

ROLLERS

In addition to the pair of plain rollers required on each side of the bridge 50 feet (15.4 meters) behind the launching rollers, a pair is required 75 feet (23.1 meters) behind them. For bridges over 140 feet (43.1 meters), double rollers are required at 125 feet (38.5 meters) behind the launching rollers.

SECOND-STORY, TRIPLE-TRUSS BRIDGE

For a second-story, triple-truss bridge, the assembly is the same as that for the M2 bridge, but the sequence of adding panels must be the same as in *triple-single* assembly. It is not necessary to use headless pins, provided the order of assembly is as follows:

Bay No. l—Outer panel

Bay No. 2—Outer panel

Bay No. l—Second panel

Bay No. 3—Outer panel

Bay No. 2—Second panel

Bay No. l—Inner panel

Bay No. 4—Outer panel

Bay No. 3—Second panel

Headless pins must be used on the end posts, M3, where they are connected to the lower chords of the second truss of the second story. Tie plates are not required.

ASSEMBLY AND LAUNCHING OF TRIPLE-STORY BRIDGES

METHOD

The method of assembling and launching a triple-story bridge is the same as that for an M2 bridge, except for several factors. For a *triple-triple* bridge, the sequence of adding panels in the top story must follow the order given for a second-story, triple-truss bridge except that assembly begins in the second bay. There are no panels in the top story of the first and last bays. Similarly, the sequence for the lower story of a bridge with underslung bottom story must be the same.

LAUNCHING

For all class 30 bridges, launch the bridge with the top story in place. For the class 80 bridge with a span of 120 feet (36.9 meters), it is possible to launch the bridge as double story and add the third story afterwards.

OVERHEAD BRACING

The only difference from the assembly of the M2 bridge is that the overhead sway-brace extensions are fitted to the sway braces before they are connected to the overhead-bracing supports, which are reversed so that the sway-brace pinholes are on the outside of the girders.

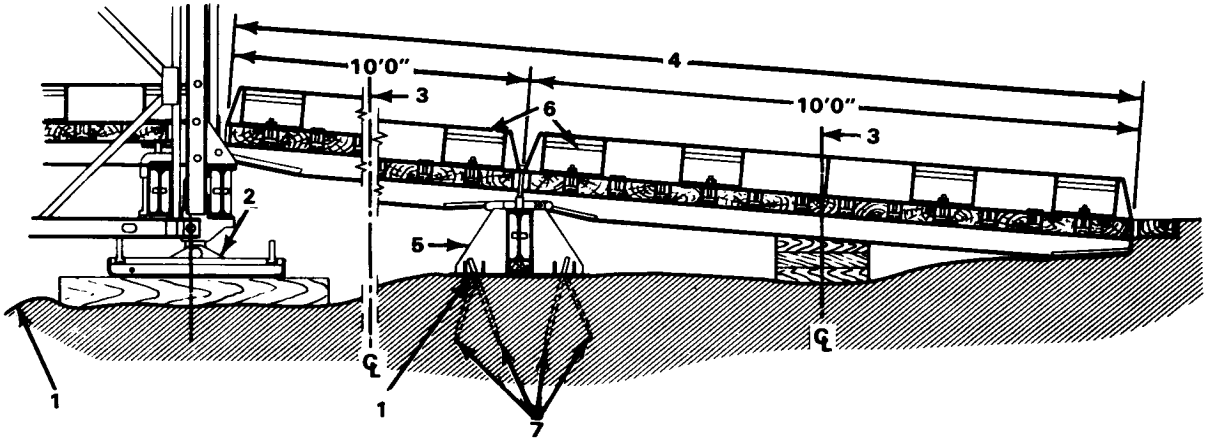
GRILLAGES AND RAMP SUPPORTS

GRILLAGES

The same grillages as those for the M2 bridge can be used. The maximum base plate reactions are given in Table 11-5 and the maximum launching roller weights in Tables 11-3 and 11-4.

RAMP SUPPORTS

The end transoms of both class 30 and class 80 bridges must be supported at their midpoint. For class 80 bridges, the ramps must be supported as shown in Figure 11-10.



1 PROVIDE PROPER TYPE OF GRILLAGE AS NECESSARY
2 BEARING
3 CENTERLINE OF RAMP
4 APPROACH RAMP-LENGTH VARIABLE IN MULTIPLES OF 10'0"
5 M3 PEDESTAL RAMP
6 RIBBAND: GUARDRAIL
7 PICKETS

Figure 11-10 ***Ramp support for class 80 bridge***

Table 11-5 ***Maximum reactions on any one base plate***

SPAN (ft)	REACTION, IN TONS, FOR EACH SPAN AND TYPE OF CONSTRUCTION			
	CLASS 30		CLASS 80	
	TYPE OF CONSTRUCTION	REACTION	TYPE OF CONSTRUCTION	REACTION
30	SS	16.7	DS	32.5
40	SS	18.5	DS	36.1
50	SS	19.9	TS	38.7
60	DS	21.9	TS	41.6
70	DS	23.4	DD	44.5
80	DS	24.7	DD	46.4
90	TS	27.2	TD	51.1
100	TS	28.5	TD	53.7
110	TS	29.7	TD or DT	57.6
120	DD	32.5	TT	64.8
130	DD	34.2	TT	67.6
140	TD	40.4	TT	71.8
150	TD	42.8	TT	76.4
160	DT	47.2		
170	DT	49.6		
180	DT	52.1		
190	TT	62.3		
200	TT	65.3		

CHAPTER 12

DECK-TYPE BRIDGES

Deck-type panel bridges are normally two-lane, class 50 or higher bridges assembled to replace single-lane bridges. A deck-type panel bridge has the following advantages over a through-type bridge

- Roadway can be wider for passage of extra-wide vehicles.
- Deck-type assembly allows greater side overhang of vehicles.
- A lighter decking system can be used when the roadway is supported by trusses.
- With some sloping banks, the span between abutments is shorter than in a through-type bridge, because bearings are set 5 feet (1.5 meters) below road level.
- Demolished piers need not be built Up to the level of the roadway.
- There are no overhead restrictions.

A deck-type panel bridge has the following disadvantages:

- Excavation at abutments may be necessary because bearings are 5 feet (1.5 meters) below the roadway.
- It is more difficult to launch.
- It must be lowered 5 feet (1.5 meters) onto the bearings.
- Waterway clearance is decreased.

RECOMMENDED BRIDGE DESIGNS

Use the following guidance in designing deck-type bridges:

- Group the trusses into three-truss girders, and space girders evenly under the roadway. The trusses may be single-or double-story assembly, as shown in Figure 12-1.
- Use bracing frames staggered at opposite ends of each bay (see Figure 12-1) to tie the trusses of each girder together. Every two bays are cross braced by angles welded diagonally across the bottom chords of all trusses. The decking system serves as top lateral bracing.

  Make the decking system from standard panel-bridge parts (transom, stringers, and chess) or timber.
- End posts attached to top-story panels may be rested on standard panel-bridge bearings. In multistory assembly, omit the end panels of the lower stories to allow room for the abutment. If end posts are not used, rest the trusses on timber blocking or a rocker bearing under the joint between the first and second bay from each end. If the spans are broken at the pier, fit the two ends with end posts. If the spans are continuous, use a distributing beam and rocker bearing (see Chapter 16).

CLASS

The capacity of the standard two-lane deck-type panel bridge varies with the span and the number of traffic lanes loaded. The bridges are given two class ratings, one for one-way traffic and the other for two-way traffic. Each of these ratings may be either a single or a dual classification. For maximum spans and classes of standard design two-lane deck-type bridges, see Table 12-1 (page 140).

STANDARD DESIGNS

Standard design deck-type panel bridges are illustrated in Figure 12-1. Material requirements of the standard-design deck-type panel bridge can be found in Table A-11, Appendix A.

ASSEMBLY

The most practical load distribution is obtained by spacing the trusses uniformly under a relatively stiff deck. Use five three-truss girders (15 trusses) under the bridge deck. Space trusses in each girder 1 foot 6 inches (44.1 centimeters) apart and tie together with bracing frames.

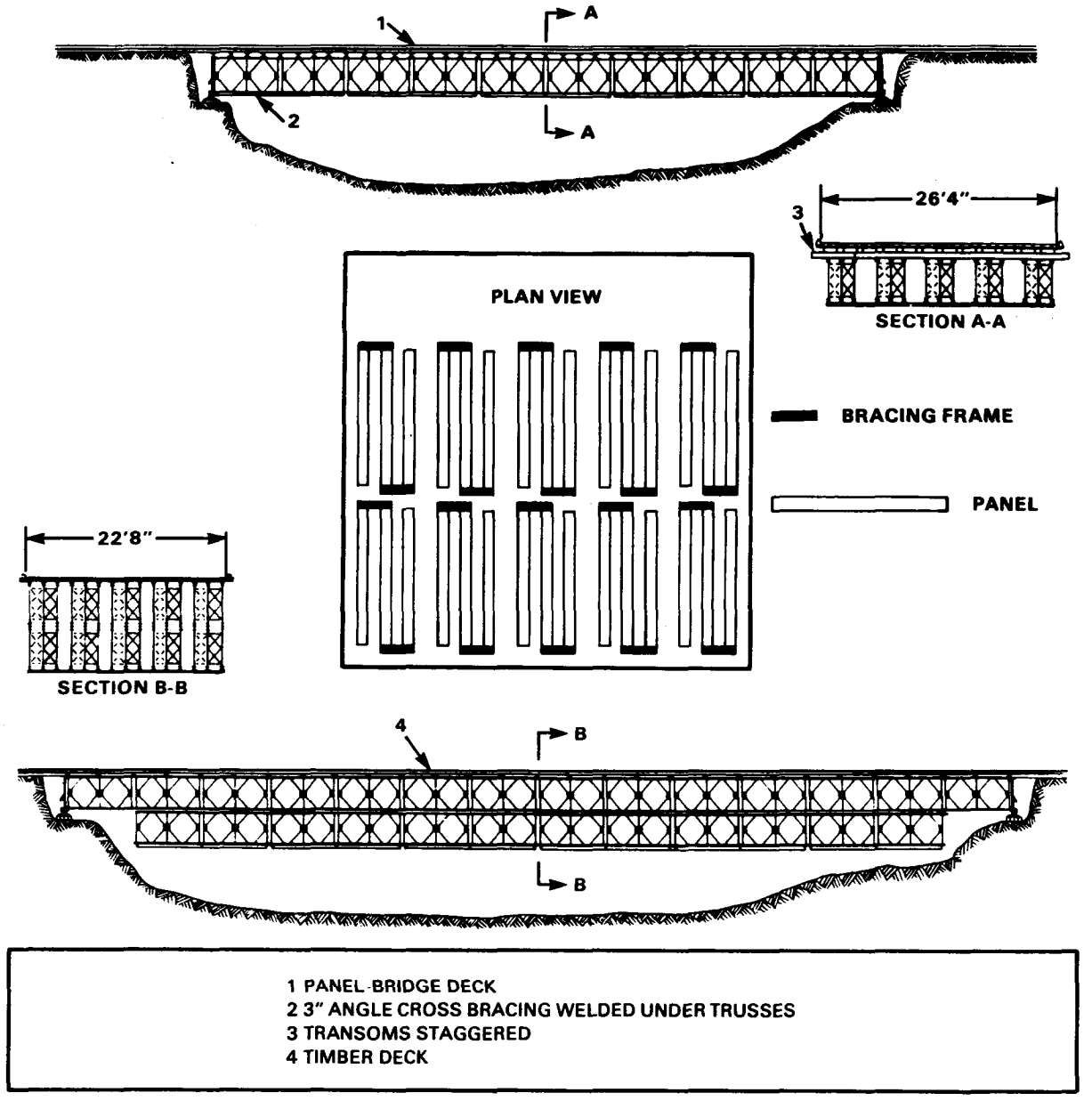


Figure 12-1 ***Standard two-lane, deck-type panel bridges***

Bracing

Use bracing frames as much as possible at panel junctions to space the trusses and to provide lateral stability in each three-truss girder. To brace and tie the five three-truss girders together, weld 3-by 3-inch (7.4 by 7.4 centimeters) angles diagonally across the bottom chords of each two bays. Welding must be done carefully so the properties of the high tensile steel in the panel-bridge parts are not changed. Use mild steel bracing members, and weld them in place before any loads are applied to the bridge.

Decking

Before the timber decking is laid, weld 3-inch (7.4 centimeters) angles transversely to the top chords of the trusses at 5-foot (1.5 meters) centers. These angles tie the trusses together and provide a brace for clamping the ribband bolts.

Laminate the timber decking or lay it in two layers. Laminated decking (Figure 12-2, page 141) is better than layered decking because the nails cannot work out under traffic vibration. This reduces maintenance. Lay timbers on edge perpendicular to the long axis of the bridge and nail together horizontally. For ease of assembly, 2½-foot (73.5 centimeters) sections of laminated deck can be prefabricated before-hand and then two sections laid between each pair of angles. Notch the end timber of each section to fit over the horizontal legs of the angles. Then nail timber wear treads to the deck.

For layered decking (Figure 12-3, page 142), lay 3- by 12-inch (7.4 by 29.4 centimeters) planks across the trusses between the angles. Notch every fifth timber to fit over the horizontal legs of the angles. Then nail timber wear treads to the deck.

Bearings

When end posts are used (Figure 12-4, page 143), place them at both ends of each truss and seat them on standard bearings. Cutoff the top lugs of the end posts flush with the trusses so they do not interfere with the decking.

When end posts are not used (Figure 12-4), support the span on timber blocking at the first panel junction from each end. The timber blocking must extend at least 1 foot (29.4 centimeters) on each side of the joint. An alternative method is to use a distributing beam on a rocker bearing similar to the support over immediate piers. With this type of bearing, the effective bridge length is 20 feet (15.2 meters) greater than the gap between bearings. Also add timber blocking under the cantilevered end of the panel to eliminate a reversal of stress in panels near the end of the bridge as a vehicle moves onto the bridge. Over intermediate piers, the trusses can be continuous or broken. If they are continuous, provide a rocker bearing (Chapter 16). If they are broken, attach end posts to the ends of the trusses and seat two ends on separate bearings. If timber decking is used, the gap between the ends of the spans may require an intermediate trestle to support the decking (Figure 12-5, page 143).

Table 12-1 ***Classes and maximum spans of two-lane, deck-type Bailey bridges***

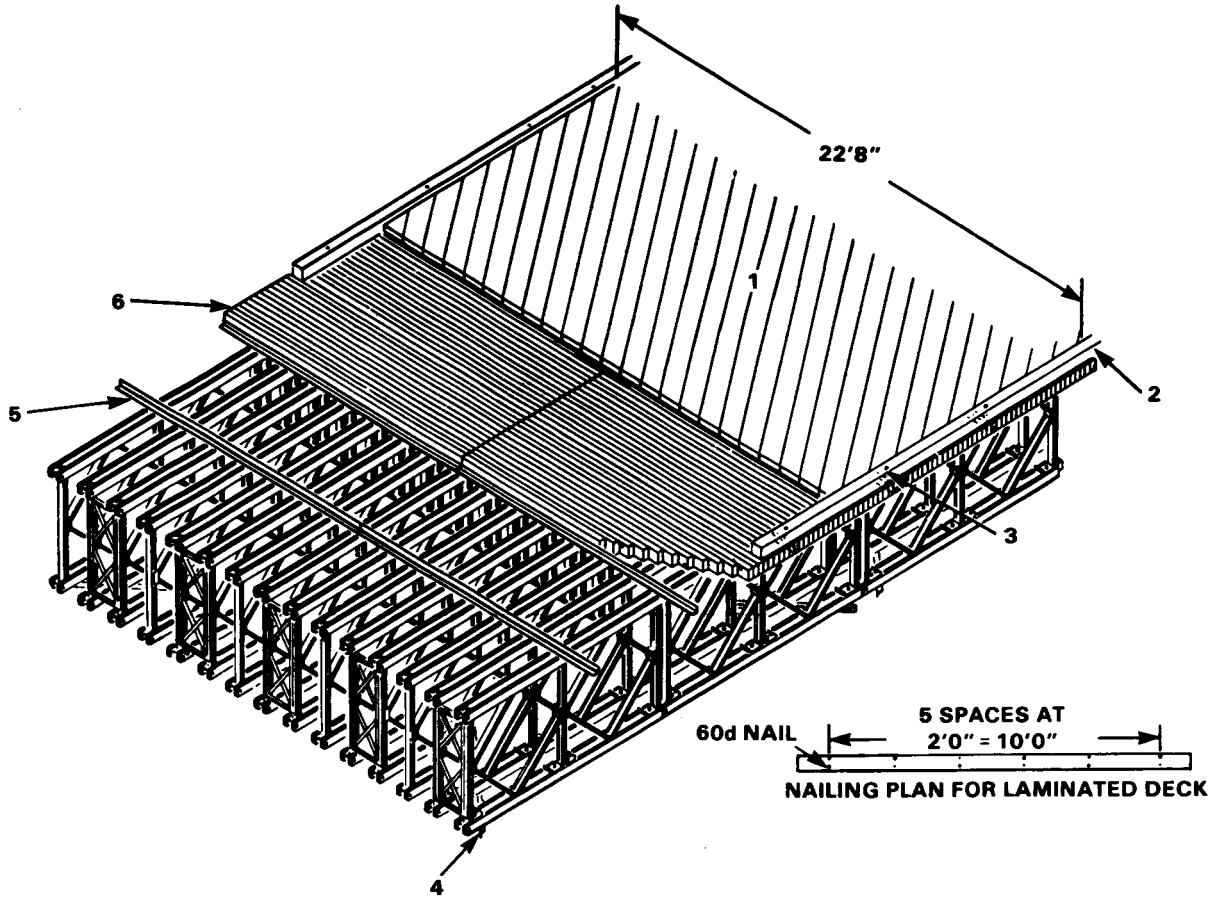
STORIES	TYPE OF TRAFFIC	LOAD CLASS	TRUSSES	SPAN (ft)																
				50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
SINGLE	ONE-WAY	10	W				100	100	75	55	45	35								
			T				90	90	75	60	45	35								
		15	W							100	85	70	55	40						
			T							90	90	70	55	45						
		18	W								100	90	75	60	45	35				
			T								90	90	75	60	50	35				
	TWO-WAY	10	W	80	70	60	55	45	35											
			T	70	65	60	55	45	35											
		15	W			100	100	65	50	40										
			T			90	90	65	50	40										
		18	W				100	100	80	65	50	40								
			T				90	90	70	65	55	45								
DOUBLE	ONE-WAY	10	W									85	75	60	45	35				
			T									85	75	60	50	35				
		15	W												90	70	55	40	30	
			T												90	75	60	45	30	
		18	W													95	75	60	45	30
			T													90	80	65	45	30
	TWO-WAY	10	W					50	50	45	40	40								
			T					55	50	50	45	40								
		15	W								80	70	60	50	40					
			T								75	70	60	55	45					
		18	W									90	80	65	55	45				
			T									90	80	70	60	50				

Note:
W represents wheeled-load class
T represents tracked-load class

With panel-bridge decking, the gap between the ends of spans can be bridged by expedient timber or steel stringers and chess (Chapter 16).

EXPEDIENT ASSEMBLY

For ease in launching, group trusses into two- or three-truss girders tied together by bracing frames. (Space these girders uniformly under the deck.) If other spacings of the trusses are used, expedient braces must be welded to the end verticals of the panels in place of bracing frames. Cross bracing must also be welded across the bottom chords. Examples of expedient assembly are given in Table A-12, Appendix A.



1 WEAR SURFACE
2 6" x 6" TIMBER CURB
3 CURB BOLTED TO 3" ANGLES
4 3" ANGLE CROSS BRACING WELDED UNDER TRUSSES
5 (3" x 3" x 5/16") x 12'0" ANGLE WELDED TO TRUSSES
6 TIMBER DECK LAMINATED FROM 3" x 6" x 12'0" TIMBERS

Figure 12-2 ***Details of laminated timber deck on a two-lane, deck-type panel bridge***

LAUNCHING

Use the following guidelines when launching a deck-type panel bridge:

- Each three-truss girder may be launched separately, or the entire bridge may be launched as a unit by welding added bracing to tie the girders together.
- Launch individual girders of a single-story bridge by pushing or pulling the girder and launching nose out over the gap, by launching from a high line, by launching with derrick and preventer tackle, or by lifting directly into place with one or two cranes. Over a water gap, girders may be placed on rafts and floated out into the gap and then lifted into place by a crane on a raft. See Chapter 19 for details of these launching methods.
- A single-story bridge may also be launched as a unit by pushing or pulling it on rollers out over the gap.

Use the following guidelines when launching a double-story bridge as a unit

- Tie the girders together by transverse channels welded across the tops of the bottom and intermediate chords.
- The entire unit may be launched with a launching nose and then jacked down onto the bearings.
- If a temporary pier can be built in the middle of the gap to support the cantilevered end, the bridge can be launched as

a single-story platform just below the near-bank seat. This method reduces the jacking height. It is similar to the method for launching triple-story bridges with the underslung bottom story described in Chapter 8.

LOWERING TO BEARINGS

A crane at each end of the bridge can be used to lower the girders to the bearings. Jacks can be used as an expedient, although the 5-foot (1.5 meters) drop requires several lifts. During jacking, blocking must be used under the trusses to take the load in case the jacks fail.

EXPEDIENT DESIGN BRIDGES

Table A-12, Appendix A lists several typical World War II deck-type panel bridges built in the European theater of operations (ETO).

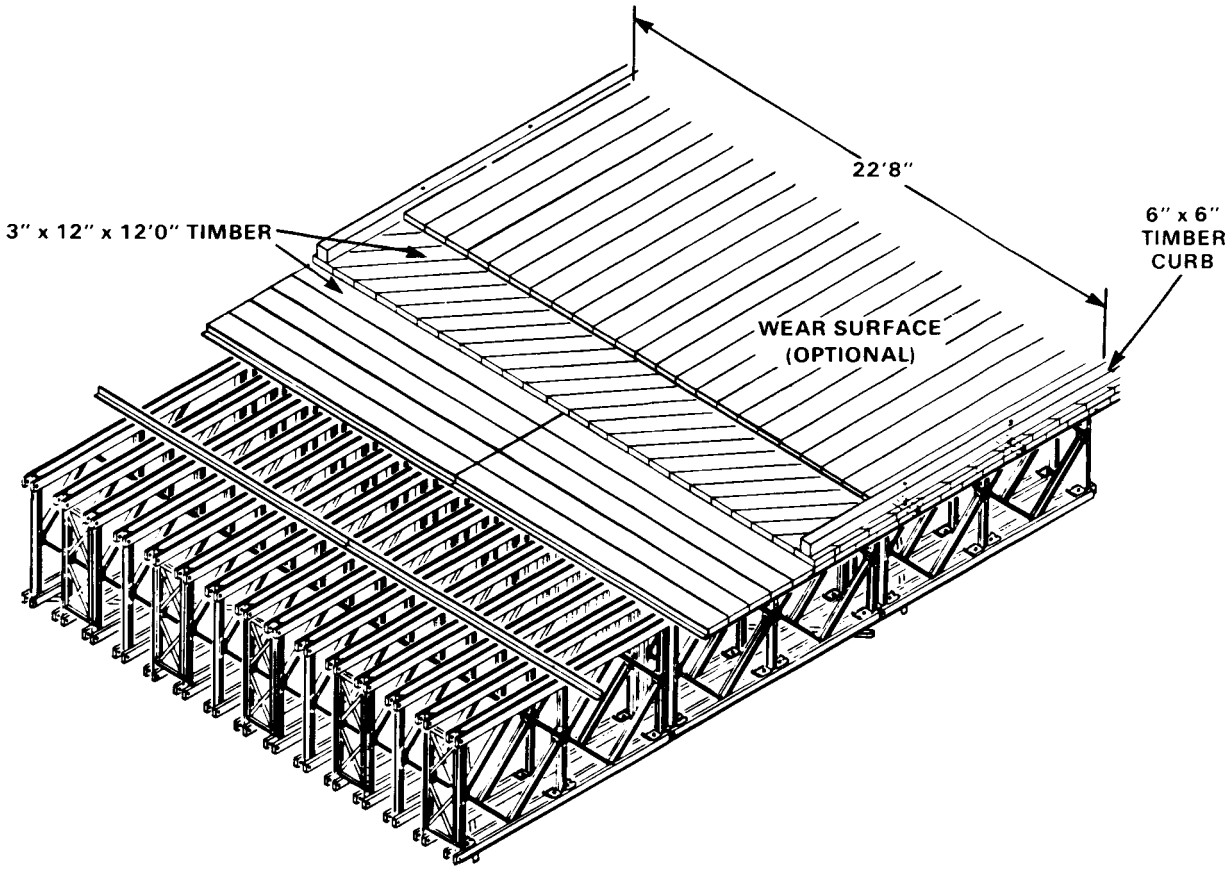
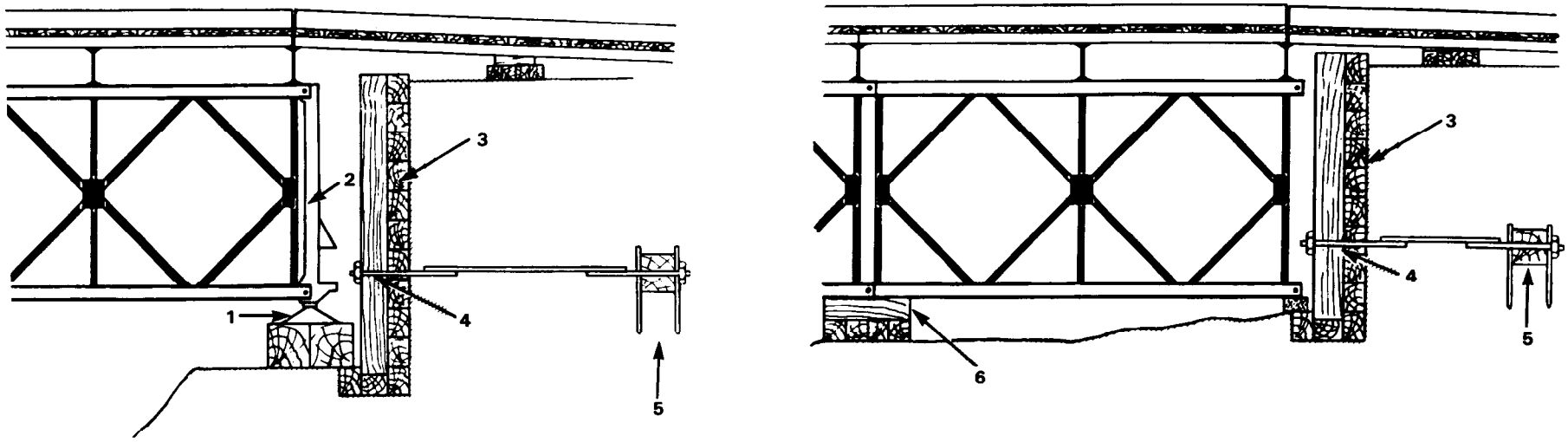


Figure 12-3 ***Details of*** *layered* ***timber deck on a two-lane, deck-type panel bridge***



1 STANDARD BEARING
2 END POST
3 TIMBER END DAM
4 6" x 8" POST
5 DEADMAN
6 TIMBER BLOCKING OR ROCKER BEARING

Figure 12-4 ***End bearings for deck-type panel bridges, with and without end posts***

Figure 12-5 ***Junction of two deck spans on an intermediate pier; timber bent supports the decking between ends of span***

CHAPTER 13
RAILWAY BRIDGES

Panel-bridge equipment can be used as an expedient for the assembly of railway bridges. However, use it only in special conditions because there is much deflection. Spans longer than 70 feet (21.5 meters) are normally impractical because a *quadruple-double* truss bridge is required (Table 13-1). Usually, panel-bridge railway bridges are assembled as single-track bridges.

Panel-bridge equipment has the following advantages for use as railway bridging

- Equipment can be transported in trucks to the bridge site. This permits bridge assembly at the same time repairs are being made on the approach tracks.
- Either through- or deck-type bridges can be assembled.

Panel-bridge equipment has the following disadvantages for use as railway bridging:

- Through-type bridges provide restricted clearance.
- Traffic over bridge must be controlled to eliminate excessive vibration and side sway.
- Pin clearance allows more sag than is found in a normal bridge.

Table 13-1 Number of trusses required for various spans of Bailey-type panel railway bridge

SPAN (ft)	STANDARD COOPER'S E-45 LOADING[1]			MODIFIED COOPER'S E-45 LOADING[1]		
	THROUGH-TYPE BRIDGE[2]	DECK-TYPE BRIDGE[3] TYPE I	DECK-TYPE BRIDGE[3] TYPE II	THROUGH-TYPE BRIDGE[2]	DECK-TYPE BRIDGE[3] TYPE I	DECK-TYPE BRIDGE[3] TYPE II
10	DS			DS		
20	DS			DS		
30	TS	6		TS	6	
40	QS and DD	7	7	QS and DD	7	7
50	QS and DD	8	8	QS and DD	8	8
60	TD	9	9	TD	9	9
70	QD	10	10	QD	10	10
80	QD	11	12	QD	11	12
90			16			16
100			16			16

Type of Construction	SS	DS	TS	QS	DD	TD	QD	DT	TT
Allowable shear (tons)	40	80	110	140	135	175	215	135	175
Allowable moment (ft-tons)	760	1,520	2,080	2,640	2,800	3,760	4,720	5,240	7,024

[1]Including an allowance of 25 percent of live load for impact
[2]Based on allowable shear and moment values
[3]Based on allowable shear in each truss of 20 tons, allowable moment in each truss of 380 foot-tons, and 90 percent truss efficiency

- Bridge requires more maintenance than a standard bridge.

RAILWAY BRIDGE ASSEMBLY

Railway panel bridges are either through-type or deck-type. Assemble the through-type railway bridge the same as the normal panel bridge, but use ties and rails in place of chess. Girders can be single-, double-, triple-, or quadruple-truss and single- or double-story. The trusses of double-story bridges infringe US main line and Berne international clearance gages but allow passage at slow speeds (Figure 13-1). If decking of double-story trusses is placed in the top story, the trusses do not infringe standard clearance gages.

In the deck-type railway bridge, space the trusses under the ties. The trusses are usually single story. Tie them together laterally by

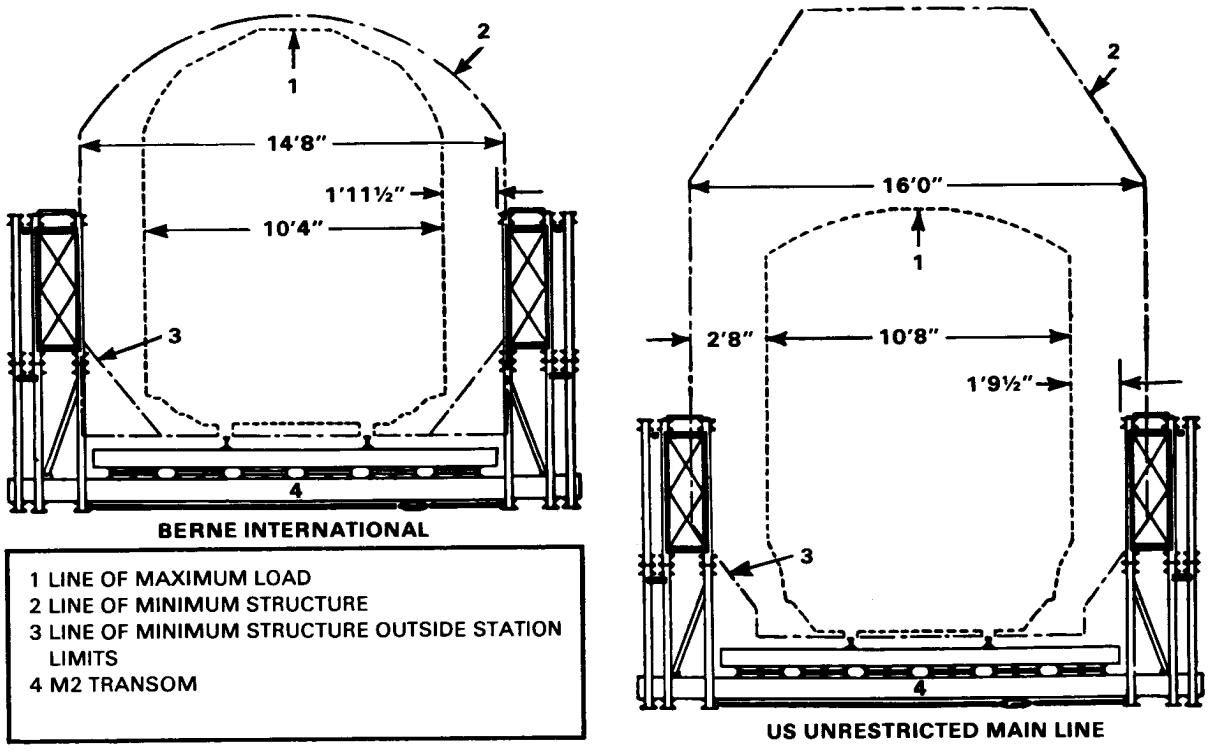


Figure 13-1 ***Railway clearance diagrams for M2 through-type panel bridges***

Table 13-2 ***Maximum live-load moments and live-load shear caused by Cooper's E-72 loadings***

SPAN (ft)	COOPER'S E-72 LOADING STANDARD (TWO LOCOMOTIVES) MAX SHEAR (tons)	MAX MOMENT (ft-tons)	MODIFIED (SINGLE LOCOMOTIVE) MAX SHEAR (tons)	MAX MOMENT (ft-tons)
10	54	101	54	101
20	90	371	90	371
30	114	739	114	739
40	136	1,182	136	1,182
50	157	1,696	157	1,696
60	176	2,336	176	2,314
70	198	3,072	195	2,952
80	222	3,904	214	3,685
90	246	4,800	232	4,466
100	270	5,808	253	5,299

bracing frames, tie plates, expedient angle cross bracing, and the ties.

CLASS

The standard designs described will carry standard or modified Cooper's E-72 loading. See Figure 13-2 (page 146) for diagrams of loadings. Table 13-2 gives the shears and moments caused by these loadings. Table 13-1 gives the assembly required for 10-to 100-foot (3.1 to 30.1 meters) spans using two standard designs.

ASSEMBLY OF THROUGH-TYPE BRIDGE

Single-, double-, and triple-truss assembly can be used as in normal panel-bridge assembly. A quadruple truss can be assembled by inserting a fourth truss between the inner and second truss of a triple-truss assembly. Use bracing frames and tie plates to tie the four trusses together (Figure 13-3, page 147). Use transom clamps on all panel verticals except the three verticals in each bay covered by bracing frames. Modify transoms by cutting a hole in the flange and web at each end to seat the pintle of the fourth truss. Since the fourth truss interferes with the use of rakers, double-story quadruple-truss bridges are usually assembled with the decking in the top story.

Decking system

For railway loads, always use double transoms. Place stringers as in a normal panel bridge. If 8- by 10-inch (19.6 by 24.5 centimeters) by 14-foot (4.3 meters) ties are used, place them directly on the stringers at 2-inch (4.9 centimeters) spacings and hook-bolted to the button stringers (Figure 13-4 page 147). To use standard ties (6 by 8 inches by 8 feet 6 inches) (14.7 by 19.6 centimeters by 2.6 meters), lay chess and ribbands in the normal

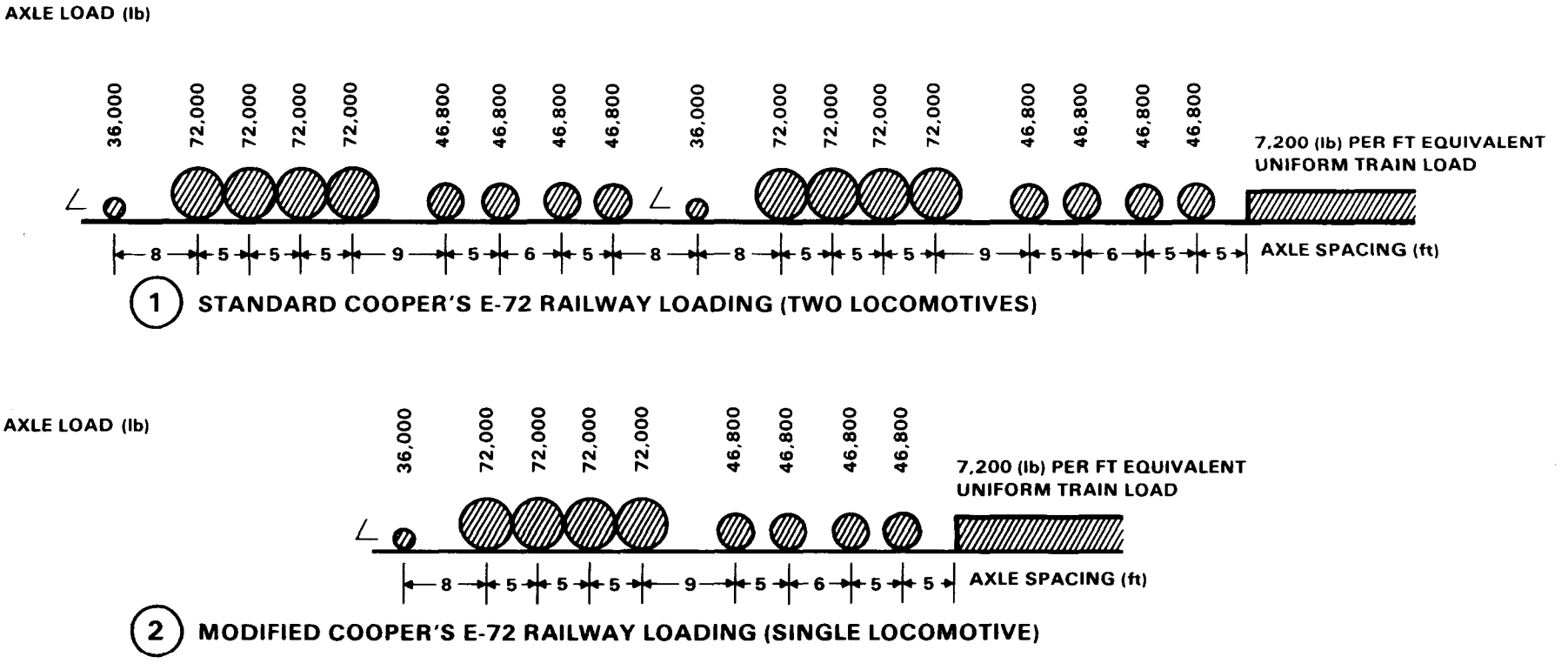


Figure 13-2 ***Diagram of standard and modified Cooper's E-72 loadings***

manner and spike the ties to the chess (Figure 13-5). By building up timber treads on each side and between the rails, the bridge can be used for rail or highway traffic (Figure 13-6). To reduce impact, rail joints on the bridge should be tight, with no allowance for expansion.

End bearings

Use end posts and bearings as in a normal panel bridge. Grillage must be enough to carry the loads given in Table 13-3. Ramp sections must be level with the bridge deck.

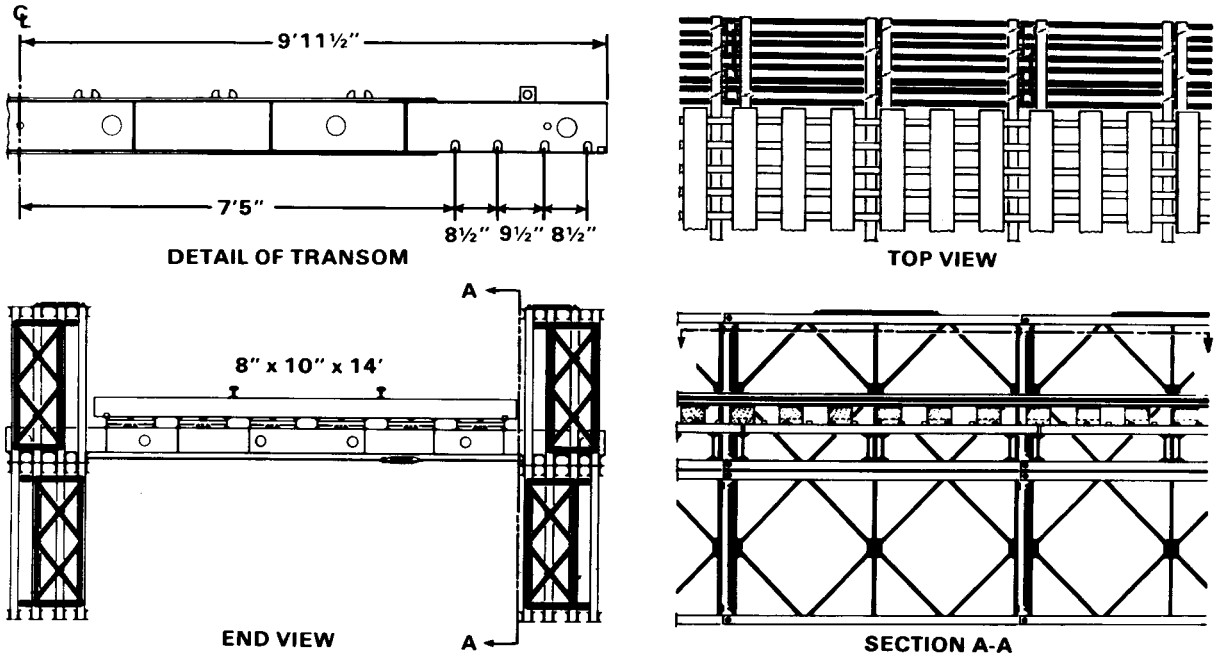


Figure 13-3 ***Through-type panel railway bridge***

Table 13-3 ***Abutment reaction, in tons, for various spans of Bailey-type panel railway bridge under Cooper's E-72 loading***

SPAN (ft)	COOPER'S E-72 LOADING					
	STANDARD			MODIFIED		
	THROUGH-TYPE BRIDGE*	DECK-TYPE BRIDGE		THROUGH-TYPE BRIDGE*	DECK-TYPE BRIDGE	
		TYPE I	TYPE II		TYPE I	TYPE II
10	65			65		
20	109			109		
30	140	93		140	136	
40	167	111	113	167	162	164
50	197	131	132	197	190	191
60	225	149	150	225	215	216
70	254	169	170	250	240	241
80	289	191	192	276	265	265
90	319	214	215	303	290	291
100			243	331		323

*Sum of reactions on both base plates

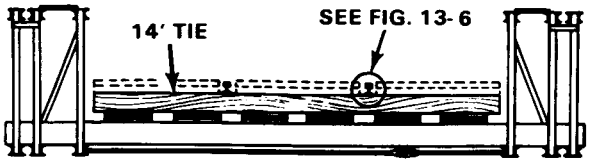


Figure 13-4 ***Decking of through-type panel railway bridge,*** *using 14-foot (4.3 meters) ties*

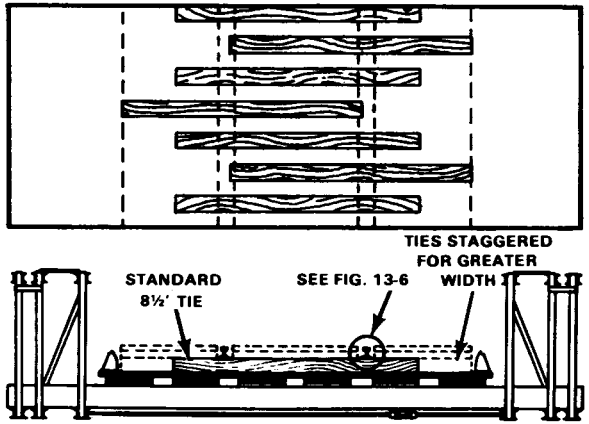


Figure 13-5 ***Decking of through-type panel railway bridge,*** *using standard 8½-foot (2.6 meters) ties*

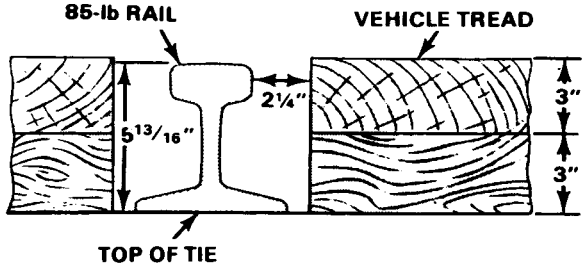


Figure 13-6 ***Decking of through-type panel railway bridge,*** *with detail of vehicle tread for combination highway-railway bridge*

ASSEMBLY OF DECK-TYPE BRIDGE

Two deck-type assembly designs are described here. *Type I* is used for spans up to 90 feet (27.7 meters), *type II* is used for spans up to 100 feet (30.8 meters). Use the following steps to assemble *type I* designs:

1 Arrange trusses side by side and connect them by bracing frames and tie plates, as shown in Figure 13-7. Bracing is supplied by the ties, welded sway bracing, and modified transoms. Seat the modified transoms adjacent to the center vertical in the top and bottom chord of every second and third bay. To seat the upper transom, invert every other truss. Cut the modified transoms to the desired length and hole them to seat the pintles on the panels. Weld three-inch (7.4 centimeters) angle sway bracing diagonally under the bottom chords of every two bays.

2 Use four 6- by 12-inch (14.7 by 29.4 centimeters) ties in each bay for the deck system. Chord bolt every other tie to the trusses. Drill holes for the chord bolts as shown in Figure 13-8 (page 150). Spike a 6-by 6-inch (14.7 by 17.4 centimeters) curb to the ties.

3 Use end posts at each end of each truss and seat them on standard bearings. Grillage under the bearings at each abutment must be sufficient to support loads given in Table 13-3. Rocker bearings over intermediate piers can be made similar to those described in Chapter 16.

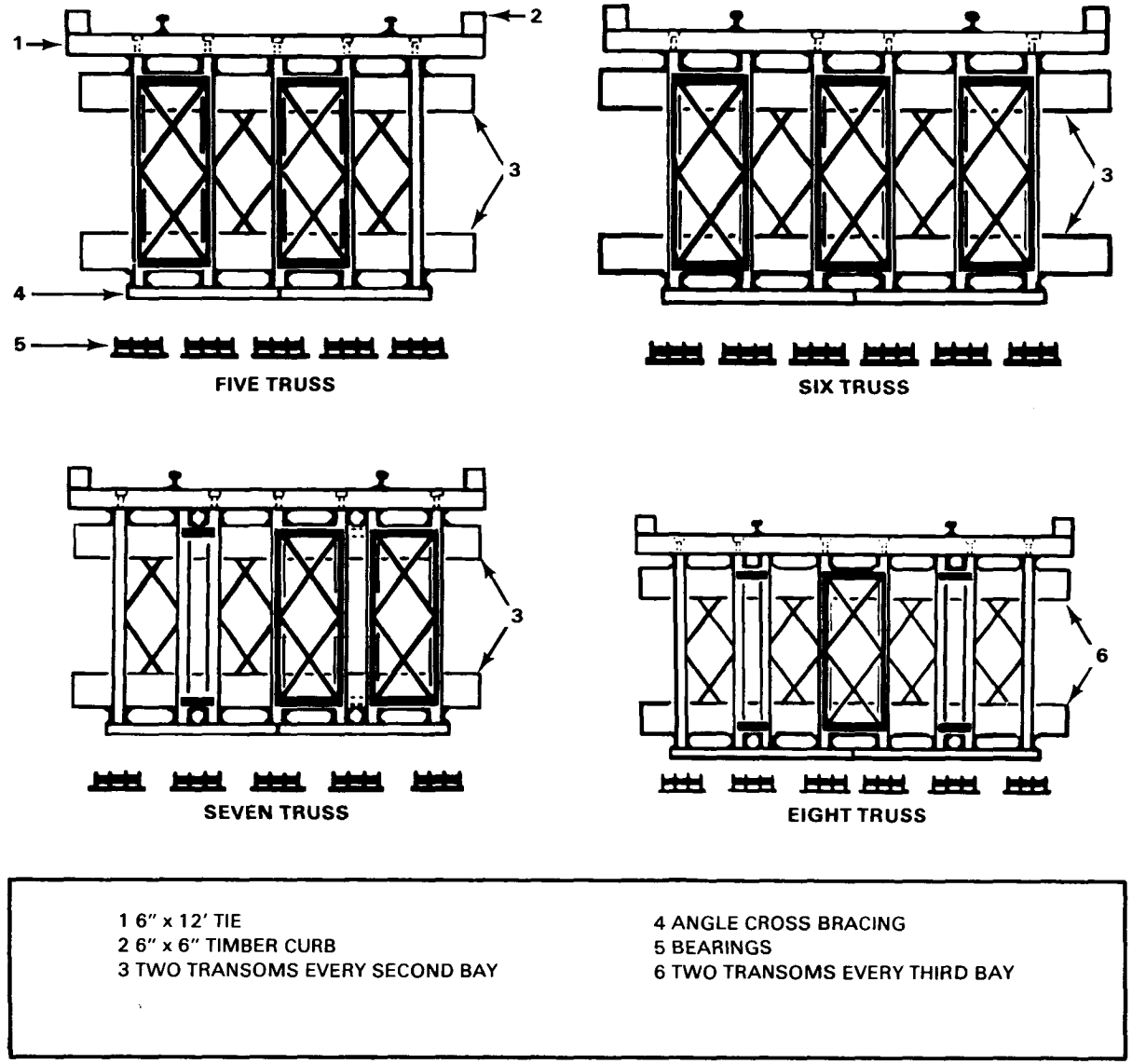


Figure 13-7 ***Railway bridge:*** *Type I*

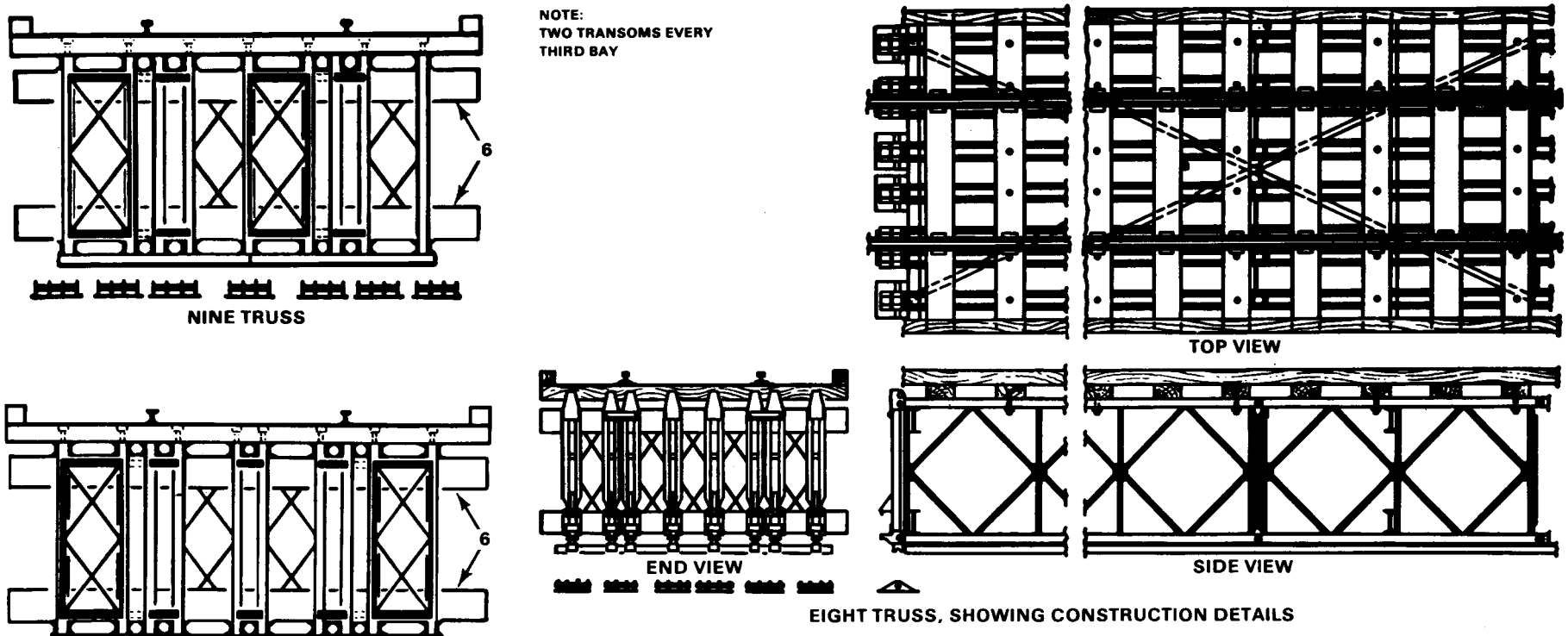


Figure 13-7 ***Railway bridge:*** *Type I—continued*

Use the following steps to assemble *type II* designs:

1 Brace trusses by bracing frames and tie plates into two-, three-, or four-truss girders suitable for launching separately. Group the girders together to form six-, seven-, eight-, nine-, ten-, twelve-, and sixteen-truss bridges as shown in Figure 13-9 (page 150). The two-truss girder is made from two trusses braced at the end verticals by bracing frames. A 3-foot (92.3 centimeters) wide three-truss girder is made from three trusses braced by bracing frames. A 1½-foot (44.1 centimeters) three-truss girder is made by adding a third truss between the trusses of the two-truss girder and bracing it with tie plates to one of the outer trusses. A four-truss girder is made by adding another truss 8½ inches (21.6 centimeters) outside a 1½-foot (45.7 centimeters) three-truss girder and bracing it with tie plates. Tie the girders together in the bridge by the ties and two modified transoms on the bottom chord of each bay. Modify transoms by cutting

holes in the flange to seat the pintles on the panels. Weld raker lugs to the transom so rakers can be used betweeen the transom and the outside trusses.

2 Use the same deck system as that used in the *type I* bridge.

3 Use bearings of the same type as those used in the *type I* bridge.

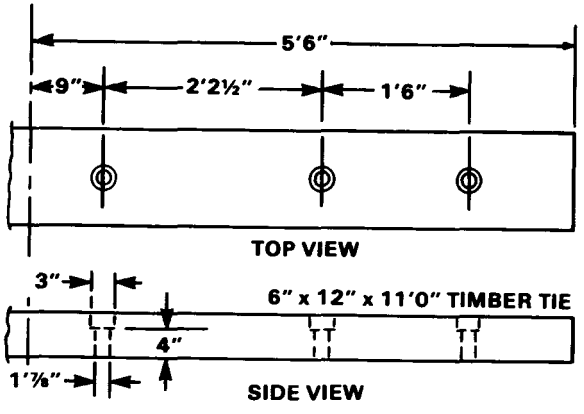


Figure 13-8 ***Details of railway tie for eight-truss bridge, showing chord-bolt holes***

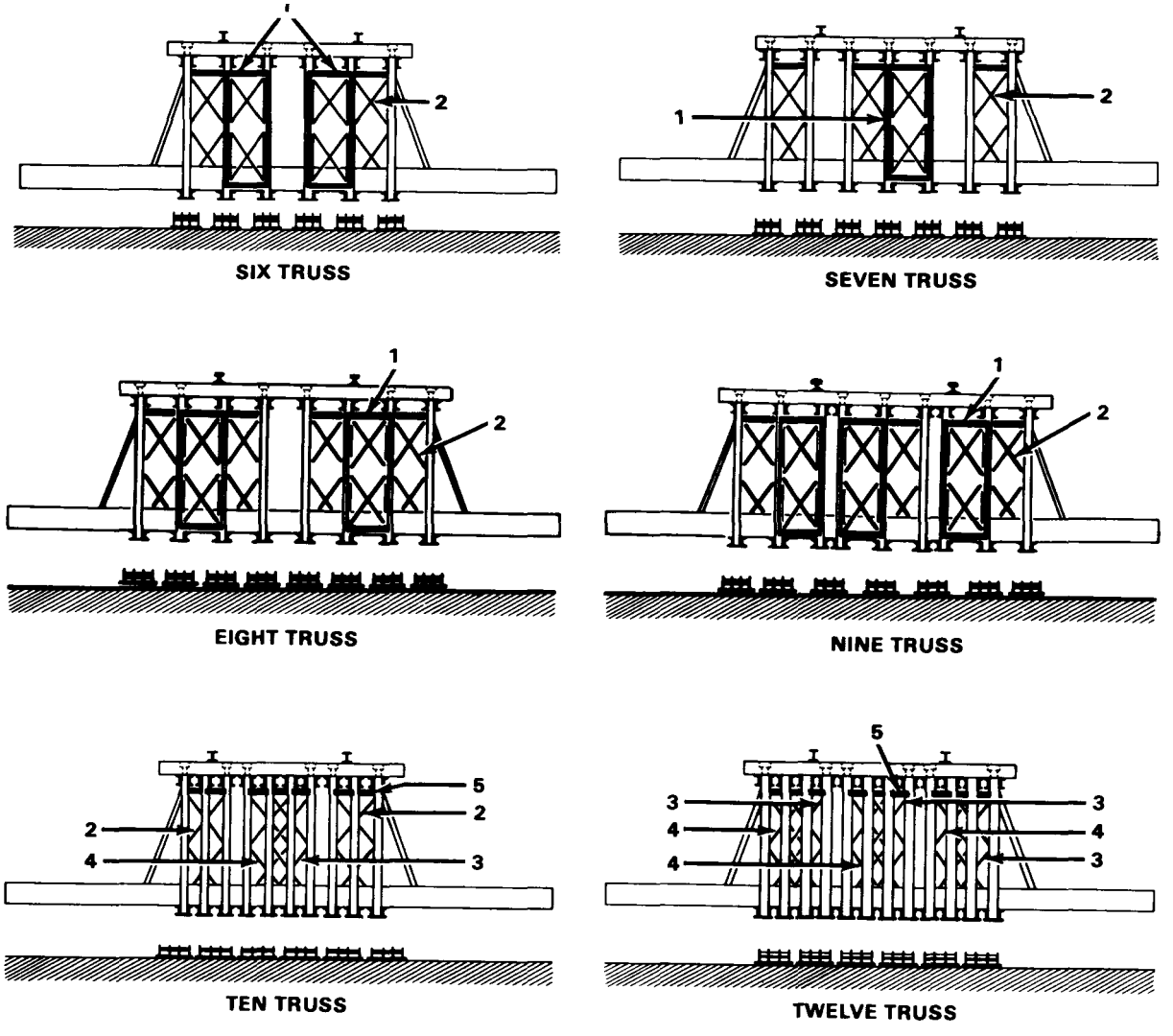
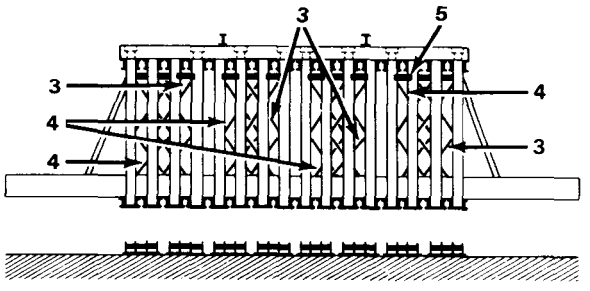


Figure 13-9 ***Railway bridge:*** *Type II*



SIXTEEN TRUSS

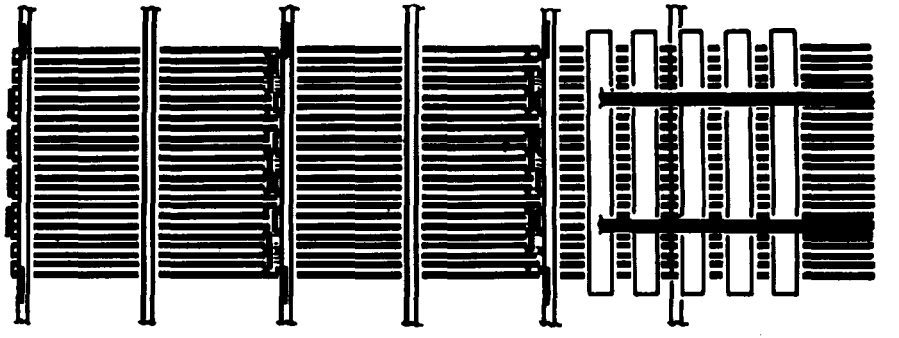
BRACING FRAMES

1 ON FRONT END OF PANELS IN EVERY BAY
2 ON BACK END OF PANELS IN EVERY BAY
3 ON BACK END OF PANELS IN ODD-NUMBERED BAYS
4 ON BACK END OF PANELS IN EVEN-NUMBERED BAYS

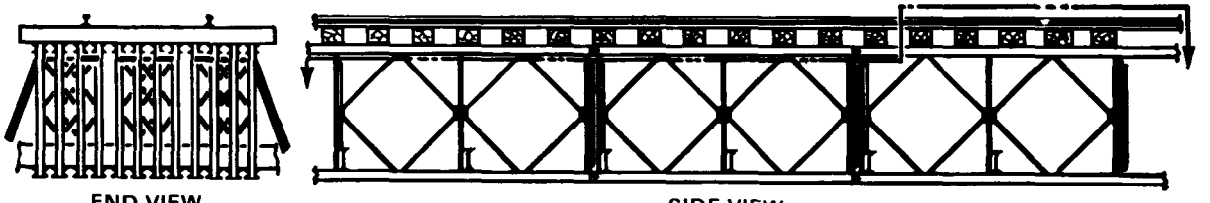
TIE PLATES

5 ON FRONT END OF PANELS IN EVERY BAY

NOTE:
NEW RAKER LUGS WELDED TO TRANSOMS AT REQUIRED SPACING



SECTION A-A



END VIEW

SIDE VIEW

TWELVE TRUSS, SHOWING CONSTRUCTION DETAILS

Figure 13-9 ***Railway bridge:*** *Type II—continued*

LAUNCHING

Launch a through-type bridge on rollers in the same manner as that for a normal panel bridge.

Use the following guidance when launching a deck-type bridge:

- *Type I* bridges are designed to be launched complete on rollers. They can be pushed or pulled across by a winch line. Launching noses can be used as shown in Figure 13-10 (page 152). During launching, use extra bracing frames and tie plates on the top chords.
- Type II bridges are launched, girder by girder, by cantilevering out on rollers. Add decking and bracing between girders after girders are in place. For other methods of launching single girders, see Chapter 19.

EXPEDIENTS

Table A-13, Appendix A lists panel railway bridges built in World War II in the European theater of operations (ETO). Figures 13-11 through 13-17 (pages 153 and 154) illustrate expedient bridges. The following expedients are available:

- Welded vertical cross bracing at each panel junction can be used instead of bracing frames and tie plates. Four-inch (10.2 centimeters) channels welded across the panel chords can be used in place of transoms.
- If end posts are not used, the abutment bearings can be made from a rigid distributing beam on timber grillage. The beam must support at least two panel-support points (Figure 13-11).

- Each truss or two-truss girder can be launched from a highline or lifted directly into place by a crane.

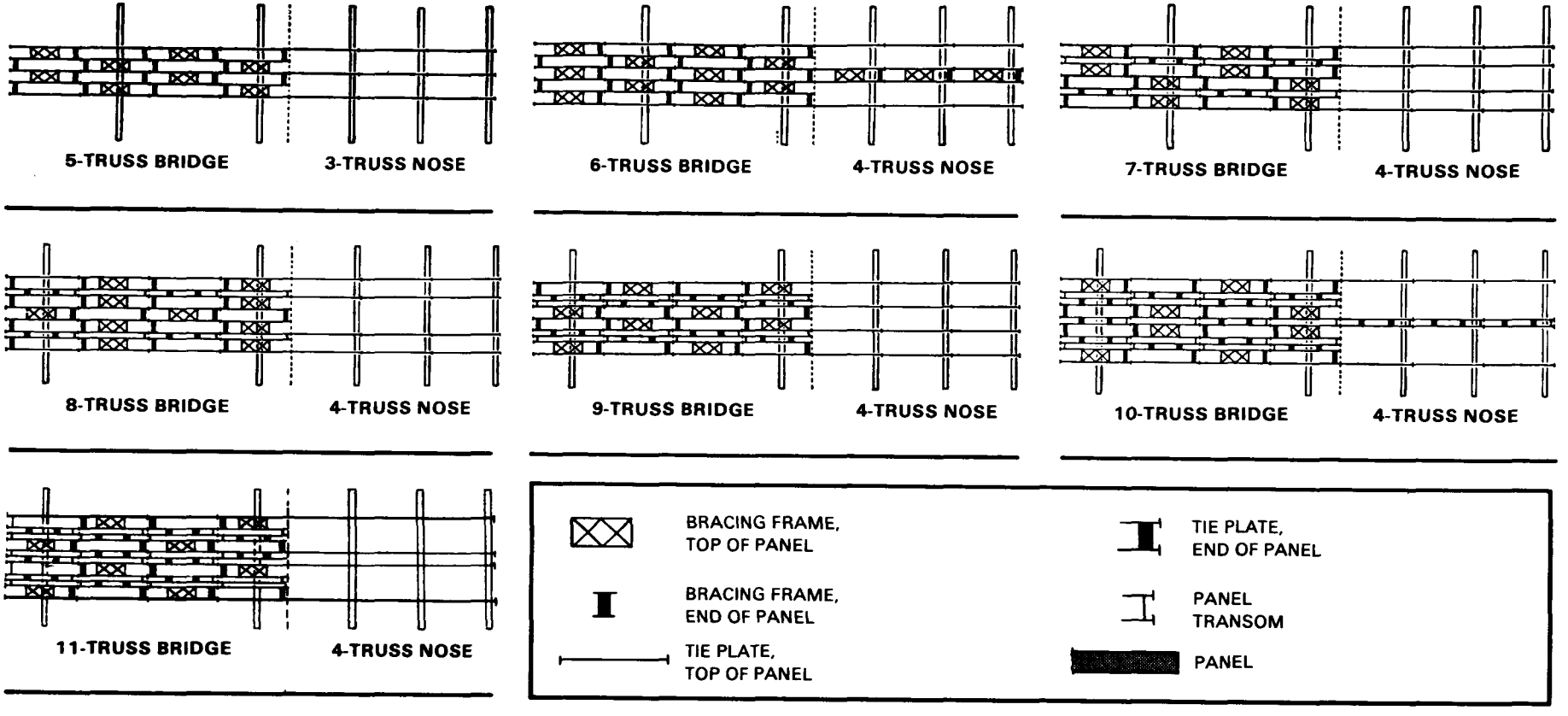


Figure 13-10 ***Bridge-bay and launching-nose combinations for*** *Type I* ***railway bridges***

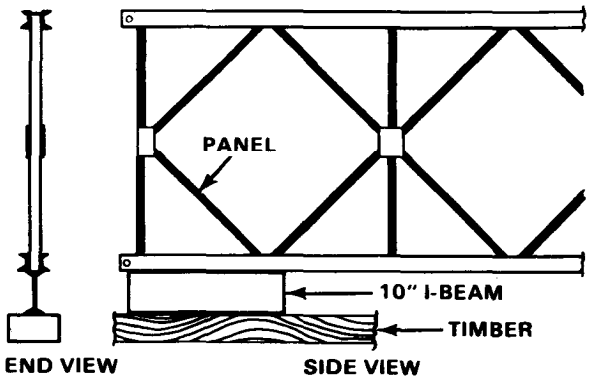


Figure 13-11 ***Expedient and bearings for deck-panel bridge***

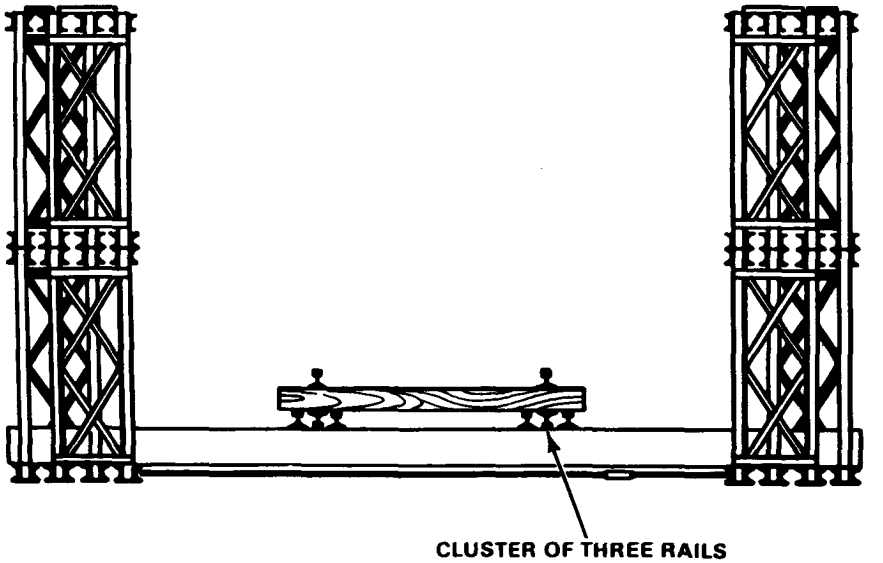


Figure 13-12 ***End view of 90-foot (27.6 meters) QD railway bridge built to carry the equivalent of Cooper's E-35 loading***

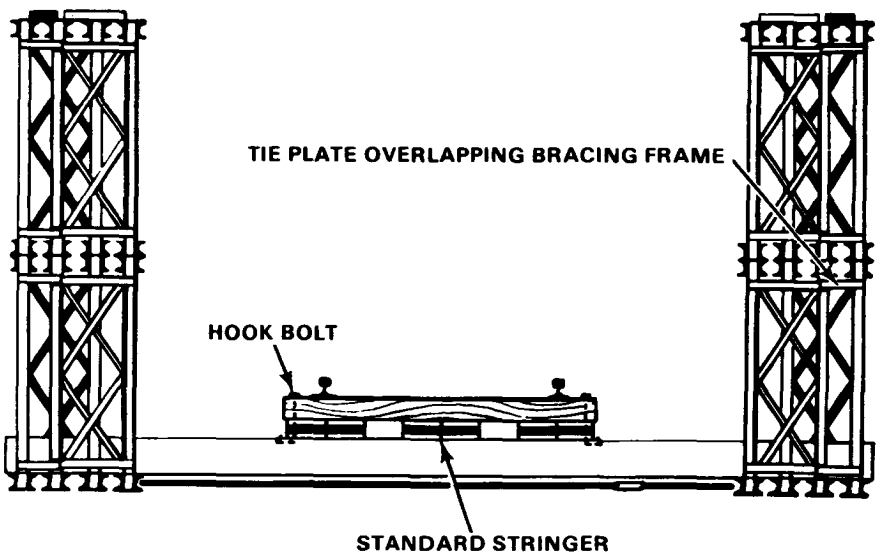


Figure 13-13 ***End view of 80-foot (24.6 meters) QD railway bridge built to carry the equivalent of Cooper's E-35 loading***

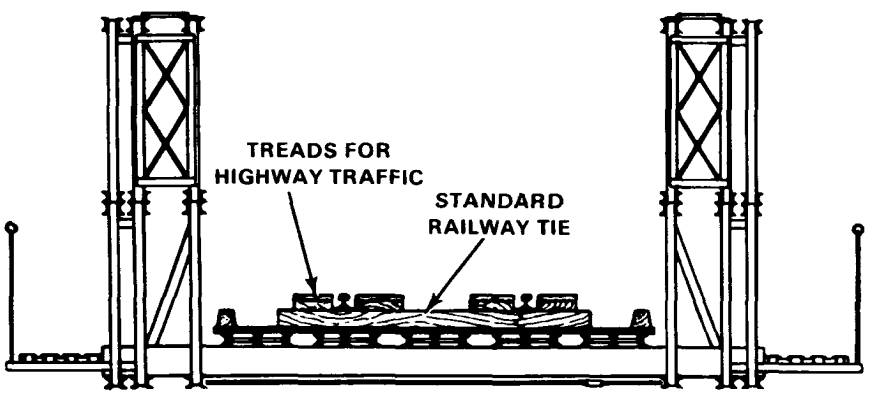


Figure 13-14 ***End view of TD combination highway-railway bridge***

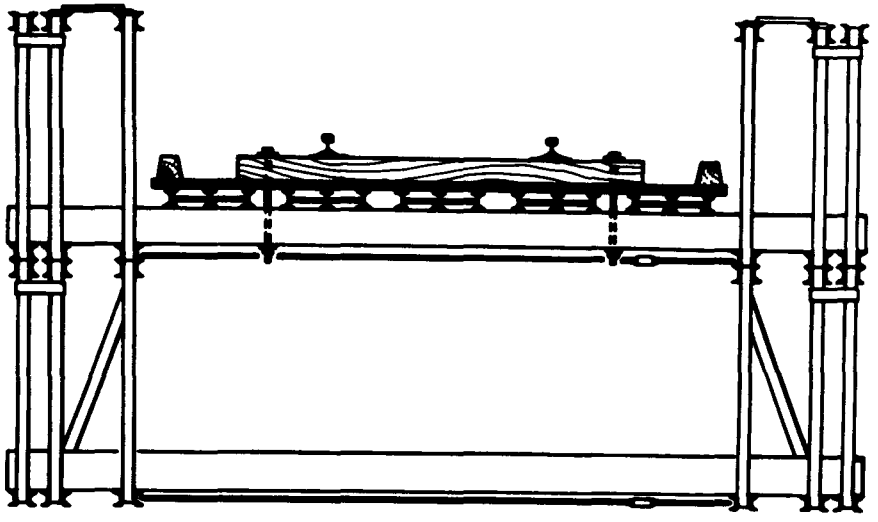


Figure 13-15 ***End view of TD class 70 railway bridge***

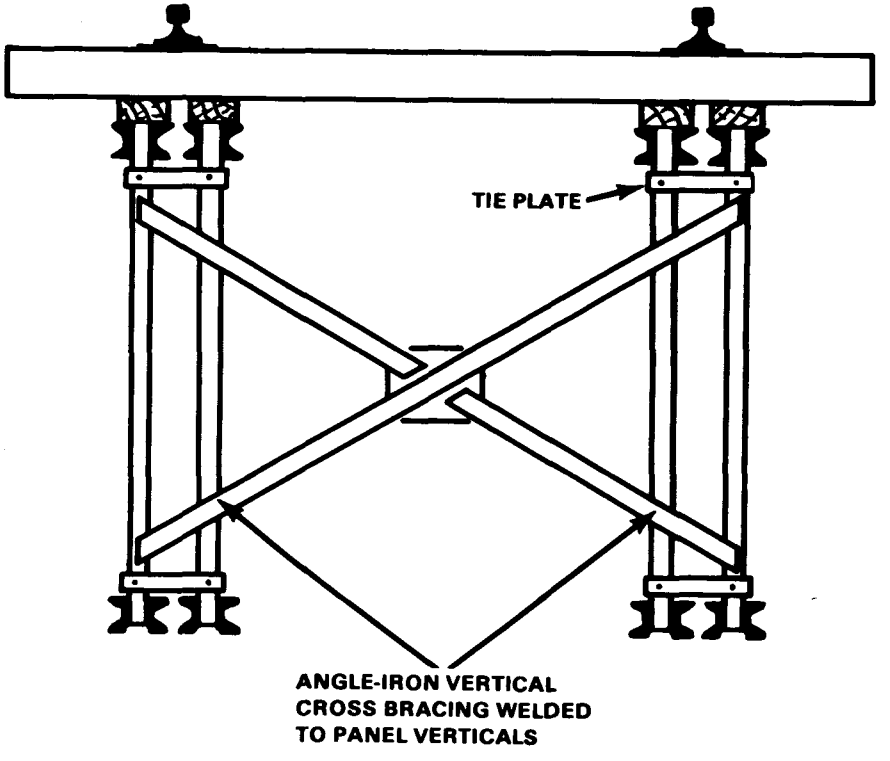


Figure 13-17 ***End view of four-truss deck railway bridge***

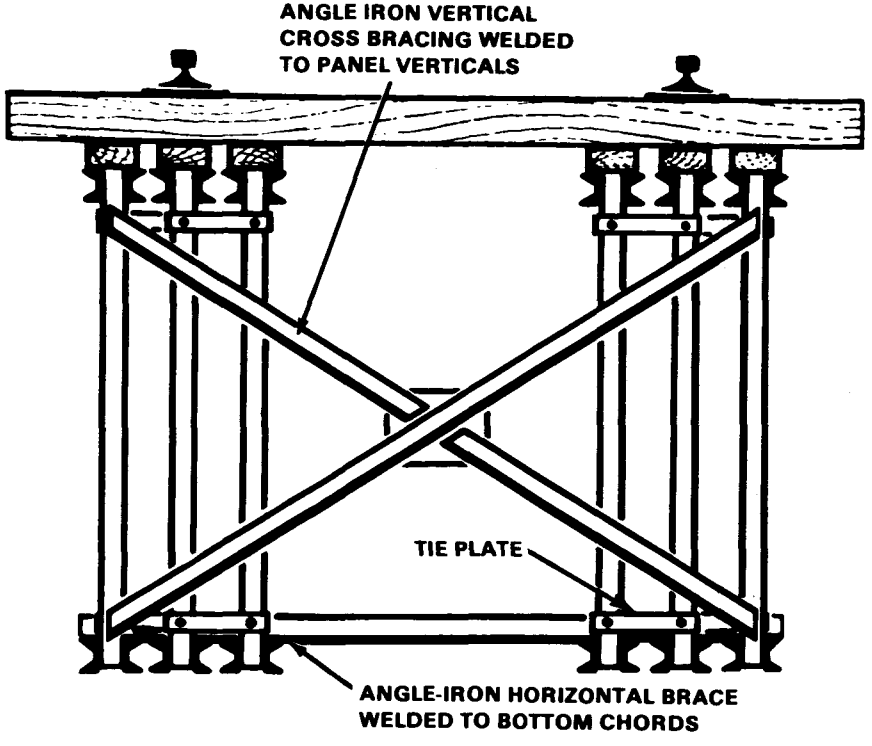


Figure 13-16 ***End view of six-truss deck railway bridge***

CHAPTER 14

REINFORCED BRIDGES

The critical design factor in most fixed-panel bridges is bending moment. This factor varies from a maximum at the center of the span to zero at the supports. Unit assembly of the panel bridge, however, produces girders of uniform section and strength throughout their entire length. Therefore, only center bays of most spans are fully stressed. The greater part of the capacity of end bays is not used. By reinforcing only the center bays where bending moment load is greatest, a more uniform distribution of stress is obtained. Reinforced bridges carry more load for bridge parts used in their assembly than do standard bridges. Short spans of *single-single, double-single, double-triple, and triple-triple* are limited in capacity by shear in end bays. They cannot be strengthened by local reinforcement of center bays and are not included in capacity Tables 14-1 and 14-2 (pages 156 and 157).

REINFORCEMENT WITH PARTIAL STORY

Double-single, triple-single, double-double, and *triple-double* bridges, not limited by end shear, can be strengthened by converting the center portion to spans double-double, triple-double, double-triple, and triple-triple, respectively. The number of bays converted depends on the increase in load class. Added panels must be complete with bracing frames and tie plates; in triple-story assembly, overhead bracing is also necessary.

Assembly and launching

Partial stories can be added before or after launching. When added before launching, use standard launching nose for complete bridges of the heavier assembly if the length of reinforcement is more than half the "span. If the length of reinforcement is half the span or less, use launching nose for standard bridge of the lighter assembly.

Class

Table 14-1 gives safe classes of bridges reinforced with partial stories. Length of reinforcement and the class of each is also shown.

Note the following

- Caution classes are all 25 percent greater than the safe values.
- Check grillage to ensure it will carry increased load.
- Build bridges with a normal rating over class 70 with double transoms.

REINFORCEMENT WITH SUPPLEMENTARY CHORDS

All types of bridges except spans limited by end shear can be reinforced with supplementary chords cut from damaged panels. Pin the supplementary chords together and bolt to existing top and bottom chords with chord bolts. Bracing frames, modified to clear the chord bolts, must be used (Figure 14-1). Overhead bracing supports cannot be used with supplementary chords unless bolts 4 inches (10.2 centimeters) longer than standard chord bolts are used. If overhead bracing supports are not used, overhead transoms can be clamped under the top chord or welded on top of the supplementary chords.

SPECIAL PARTS

Special parts for reinforced bridges are—

- Supplementary chords (Figure 14-1, page 158) cut from salvaged panels. These chords must be straight and undamaged. The web channels must be burned off and ground smooth without damaging the chord channels. Both upper and lower chords must always be reinforced. To use lower panel chords as top-chord reinforcement on all types of bridge, transom seats must also be carefully removed and ground smooth. A supplementary chord weighs about 200 pounds (90.9 kilos).
- Horizontal bracing frames on double-and triple-truss bridges reinforced with supplementary chords. These frames must be modified to clear the projecting chord bolts (Figure 14-1). Weld a tube, 1½ inch (3.8 centimeters) long and between 2¾ inches (7 centimeters) and 3¼ inches (9.5 centimeters) in internal diameter, into each longitudinal angle 8 7/16 inches

(21.5 centimeters) from the bolt holes at one end of the frame. Use an improvised jig to hold the bracing frame during cutting and welding to maintain alignment of the bolt holes. This modification does not prevent normal use of the bracing frame.

Assembly and launching

Supplementary chords cannot be added to the lower chord before launching because projecting chord bolts interfere with rollers. They can be added to upper chords, however, with no change in standard launching noses. Bracing bolts for fastening horizontal bracing frames must be inserted in supplementary chords before the chords are bolted to the truss. When chord bolts are tight, remove nuts from the bracing bolts, and add bracing frames (Figure 14-1).

Class

Table 14-2 gives the maximum safe class of bridges reinforced with supplementary chords and the corresponding length of reinforcement required.

Note the following:

- Caution classes are 25 percent greater than the safe values.
- Check grillage to ensure it will carry increased load.
- Build bridges with a normal rating over class 70 with double transoms.

Table 14-1 ***Classes of Bailey bridge M2*** *(reinforced with partial stories)*

TYPE OF CONSTRUCTION	DS			TS			DD			TD		
SIMPLE SPANS (ft)	BAYS REINF	CLASS W	T	BAYS REINF	CLASS W	T	BAYS REINF	CLASS W	T	BAYS REINF	CLASS W	T
90	0	35	40	0	65	65						
	3	40	45	5	70	75						
100	0	30	30	0	50	55	0	80	80			
	6	35	45	4	55	60	4	90	90			
				6	65	70						
110	0	20		0	35	40	0	65	70			
	7	35	40	5	45	55	5	75	80			
				7	55	65	7	80	90*			
120	0	16		0	30	35	0	45	55	0	65	70
	6	24		6	40	45	6	70	75	4	75	80
	8	30	35	8	55	60	8	75	85	6	100*	90*
130	0	12		0	20		0	35	45	0	55	60
	7	20		7	35	40	5	40	50	5	70	70
	9	30	30	9	50	55	7	60	65	7	90	90*
							9	65	70			
140	0	8		0	16		0	30	35	0	45	55
	8	16		8	30	55	6	35	40	6	60	65
	10	24		10	40	45	8	50	60	8	80	90*
							10	65	65			
150				0	12		0	24		0	35	45
				9	24	30	7	30	35	7	45	55
				11	35	40	9	45	55	9	70	80
							11	60	60	11	85	80
160				0	8		0	16		0	30	35
				8	12		8	24	30	8	40	50
				10	20		10	40	50	10	65	75
				12	24	30	12	50	50			
170							0	12		0	20	
							9	20		9	35	40
							11	35	40	11	60	70
							13	40	45			
180							0	8		0	16	
							10	12		10	30	35
							12	30	35	12	50	60
							14	35	40			
190										0	12	
										11	24	30
										13	45	50

Note:
W represents wheeled-load class
T represents tracked-load class

Table 14-2 ***Classes of Bailey bridge M2*** *(reinforced with supplementary chords)*

TYPE OF CONSTRUCTION	SS			DS			TS			DD			TD			DT			TT		
SPAN	BAYS	CLASS		BAYS	CLASS		BAYS	CLASS		BAYS	CLASS		BAYS	CLASS		BAYS	CLASS		BAYS	CLASS	
(ft)	REINF	W	T	REINF	W	T	REINF	W	T	REINF	W	T	REINF	W	T	REINF	W	T	REINF	W	T
80	0	16		0	50	55	0	85	80												
	4	20		4	65	60	4	100*	90*												
90	0	12		0	40	45	0	65	65												
	5	16		5	55	55	5	95	85												
100	0	8		0	30	30	0	50	55	0	80	80									
	6	16		6	45	50	6	80	75	4	100*	90*									
110				0	20		0	35	40	0	65	70									
				7	45	45	7	70	70	7	100*	90*									
120				0	16		0	30	35	0	45	55	0	75	80						
				8	40	40	8	65	65	8	100*	90*	6	100*	90*						
130				0	12		0	20		0	35	45	0	55	60						
				9	35	35	9	55	60	9	90	85	7	95	90*						
140				0	8		0	16		0	30	35	0	45	55						
				10	30	30	10	45	50	10	80	70	8	85	90*						
150							0	12		0	24		0	35	45						
							11	40	45	11	70	65	9	80	85						
160							0	8		0	16		0	30	35						
							12	35	35	12	55	55	10	65	70						
170										0	12		0	20	—						
										11	45	45	11	55	65						
180										0	8		0	16	—						
										12	35	40	12	45	55						
190													0	12	—	0	30	35	0	45	55
													13	45	50	9	35	35	7	50	50
200																0	20	—	0	35	40
																10	30	30	10	45	45
210																0	16	—	0	24	—
																13	30	24	11	40	40

*Limited by roadway width

Note:

W represents wheeled-load class

T represents tracked-load class

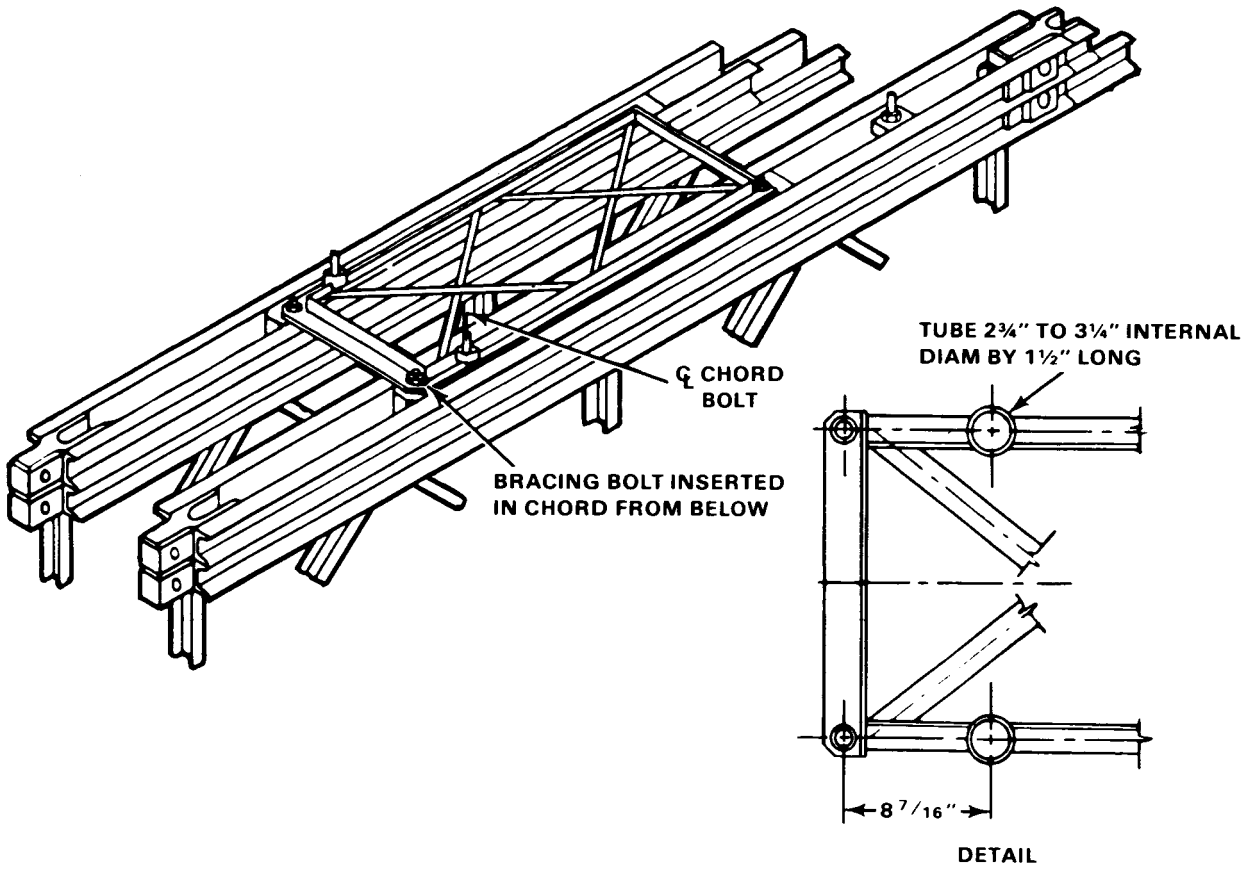


Figure 14-1 ***Supplementary chords and modified bracing frames***

CHAPTER 15

CABLE REINFORCEMENT SET

DESCRIPTION AND USE 159
COMPONENTS 167
INSTALLATION AND DISMANTLING 177
OPERATION UNDER UNUSUAL CONDITIONS 187
OPERATOR'S AND ORGANIZATIONAL MAINTENANCE 187
SHIPMENT AND LIMITED STORAGE 189

The cable reinforcement set for panel bridge M2 (Bailey type) increases to class 60 wheel and track the classification of *triple-single* Bailey bridge for span lengths from 100 feet to 170 feet (30.8 to 52.3 meters). For a span of 180 feet (55.4 meters) the class is 50 wheel and 60 track. This system significantly reduces the assembly time and equipment necessary to cross class 60 traffic over spans of between 100 and 180 feet (30.8 and 55.4 meters).

DESCRIPTION AND USE

PRINCIPLE OF OPERATION

The cable reinforcement set consists of a system of cables attached to each end of the bridge and offset from under the bridge by posts. The cables are tensioned, causing the bridge to deflect upward. When a vehicle crosses the bridge, the bridge deflects downward, transferring most of the load into the cables.

USE

To install the cable reinforcement set with a panel bridge use the following procedure:

1 Sling from two to six cables under the bridge (Table 15-1). Connect them to ends of the bridge by cable-connection beams. The standard Bailey end posts on each truss must be replaced by standard span junction posts in order to install the cable-connection beams (Figure 15-1, page 161). Hold cables away from bottom of bridge by two or four, approximately 8-foot (2.5 meters) vertical posts (Figure 15-2, page 161). The number and placement of these posts depend on bridge span length (Table 15-1).

2 Pretension cables to cable tension given in Table 15-1. The cables are tensioned by the cable-tensioning assembly, consisting of double-action hydraulic cylinders and a hydraulic power unit. Two types of hydraulic power units are used: electric and hand. The electric unit (Figure 15-3, page 162) is normally used for installation of the system. Two are needed and require one 10-kilowatt or two 5-kilowatt electric generators.

3 Check cable tension, using a hand-driven hydraulic pump (Figure 15-4, page 163). Read cable tensions directly from a cable-tension gage mounted on either hydraulic power unit. Tension cables from near bank only. The near-bank end of the bridge is called the tensioning end. The far end is called the dead end.

Six cables are provided with the set. Each cable is 179 feet 6 inches (55.2 meters) long.

On the tensioning end of the cable is a threaded stud. On the dead end of the cable are nine buttons spaced about 10 feet (3.1 meters) apart starting 100 (30.8 meters) feet from the stud end. This provides a connection of the cable at the dead end, according to the bridge span length.

TRANSPORTATION

The cable reinforcement set is transported in three 5-ton dump trucks. One truck carries the set assemblies and components (Figure 15-5), the second carries the cables (Figure 15-6), and the third carries the span junction posts (Figure 15-7).

CLASSIFICATION

The classifications in Table 15-2 are obtained with the cable reinforcement set.

Table 15-1 ***Data on use of cable reinforcement set***

SPAN (ft)		100	110	120	130	140	150	160	170	180
Number of cables required		2	2	4	4	6	6	6	6	6
Number of posts required (on each side of bridge)		1	1	1	1	1	2	2	2	2
Distance of posts from far shore (ft)	A	50	55	60	65	70	60	60	60	60
	B	0*	0*	0*	0*	0*	90	100	110	120
Cable tension (tons/cable)		20	36	30	36	28	32	38	46	44
Minimum upward deflection at midspan relative to support (inches) minus downward deflection		-2.0	-2.0	-2.0	0.0	4.0	8.5	12.5	18.5	17.5

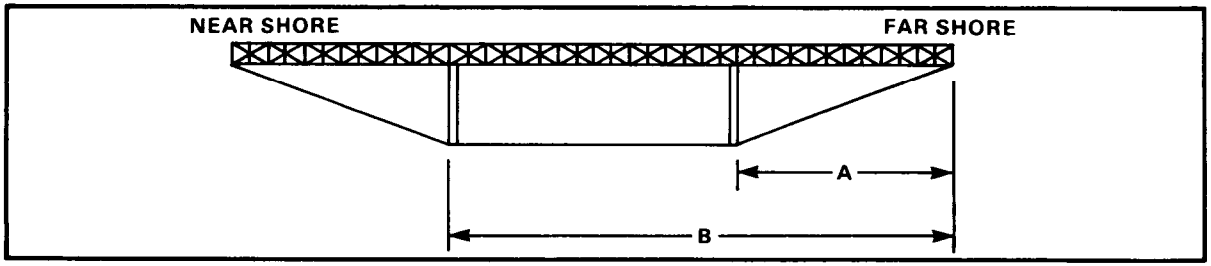


Table 15-2 ***Classification of bridges equipped with cable reinforcement set***

SPAN (ft)		100 to 170	180
Normal crossing	W	60	50
	T	60	60
Caution crossing	W	70	60
	T	70	65
Risk crossing	W	75	65
	T	75	70

Note:
W represents wheeled-load class
T represents tracked-load class

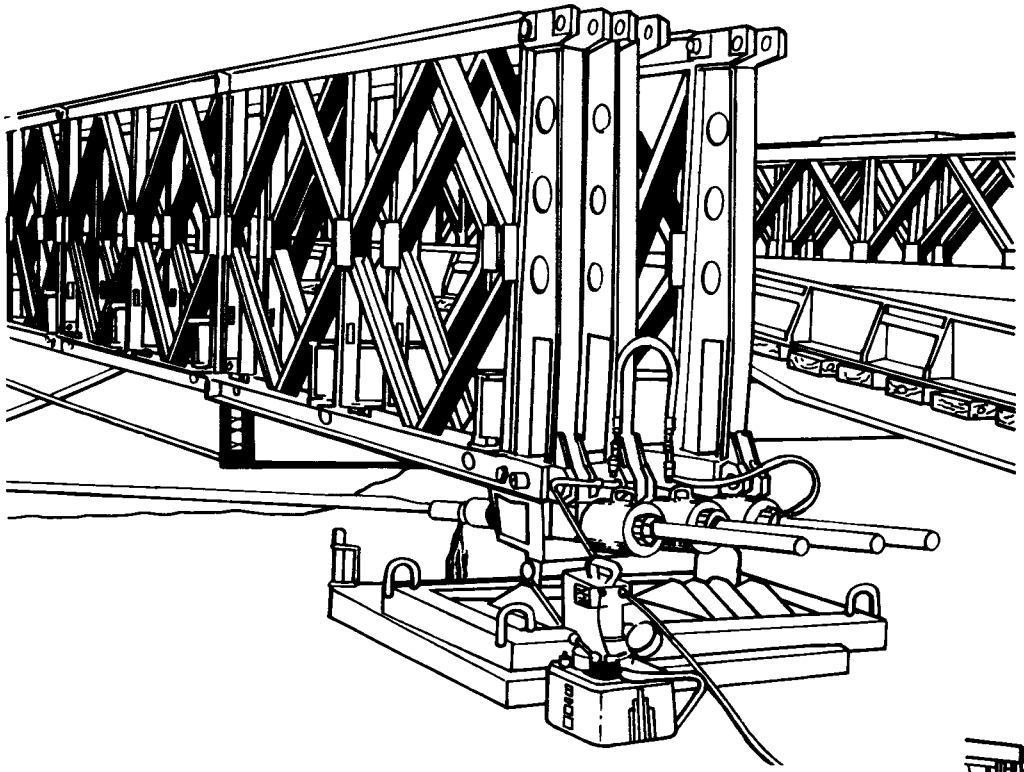


Figure 15-1 ***Span junction posts replacing standard end post on Bailey bridge with cable reinforcement set***

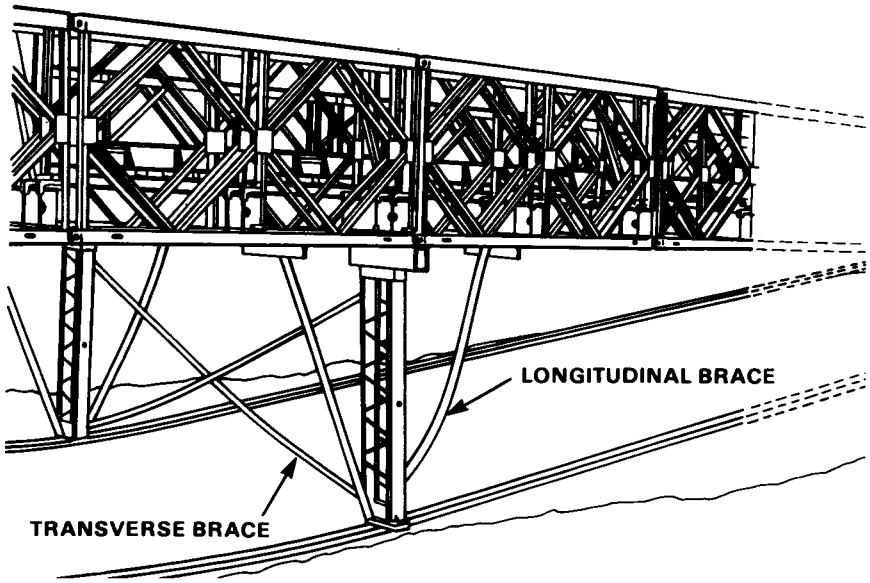


Figure 15-2 ***Cable reinforcement set vertical posts installed on Bailey bridge***

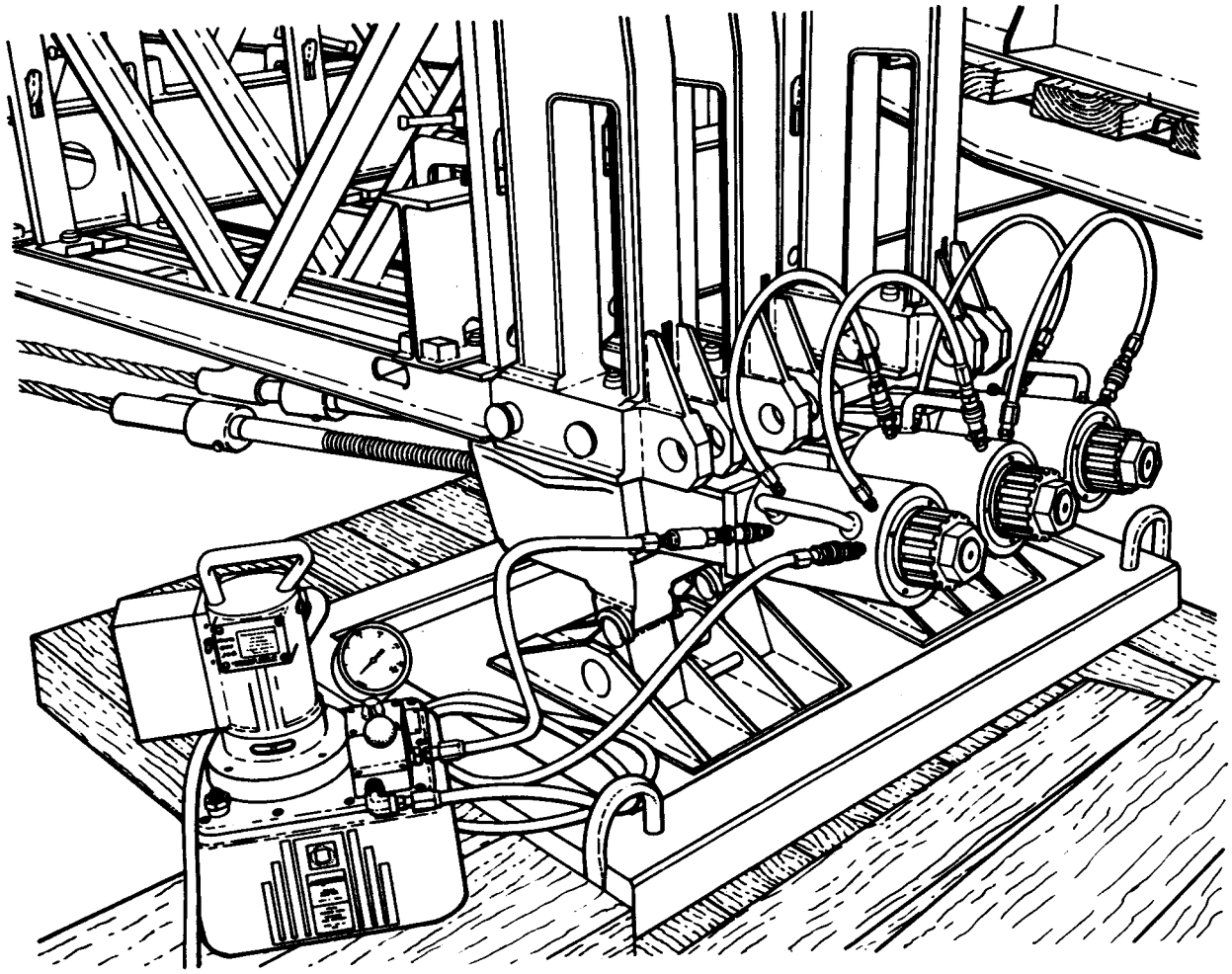


Figure 15-3 ***Cable-tensioning assembly with electric hydraulic power unit***

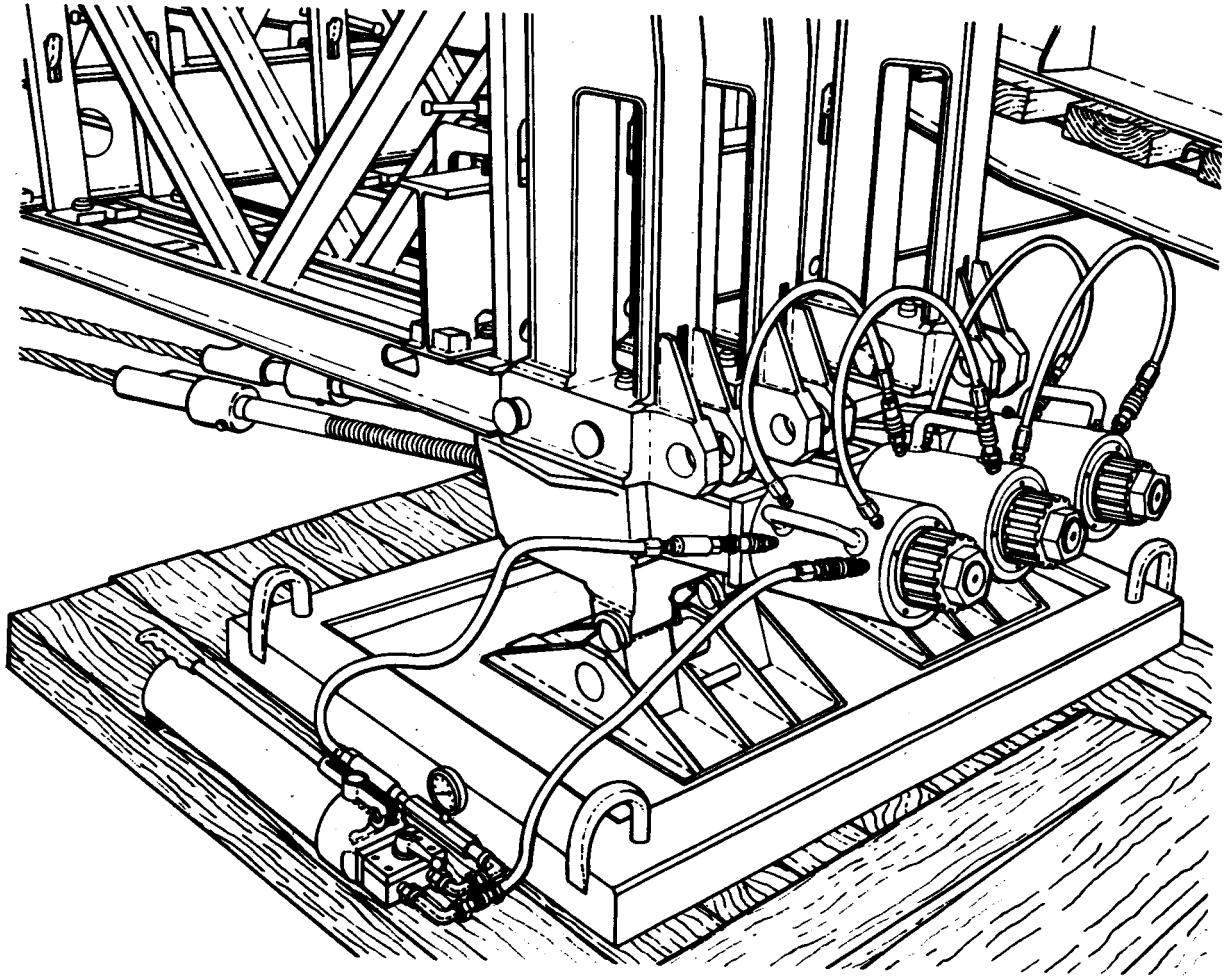


Figure 15-4 ***Cable-tensioning assembly with hand-driven hydraulic pump***

1 LASHING
2 POST-CONNECTION FIXTURES
3 POSTS ASSEMBLY
4 CABLE RETAINERS, BRIDGE SEAT ROCKERS, ADAPTERS, BOLTS, NUTS, AND JACKING LUGS
5 TRANSVERSE BRACING
6 LONGITUDINAL BRACING
7 BRACING-CONNECTION FIXTURE
8 PULL RODS
9 HAND PUMP
10 CYLINDERS
11 HYDRAULIC PUMPS
12 CABLE-CONNECTION BEAMS

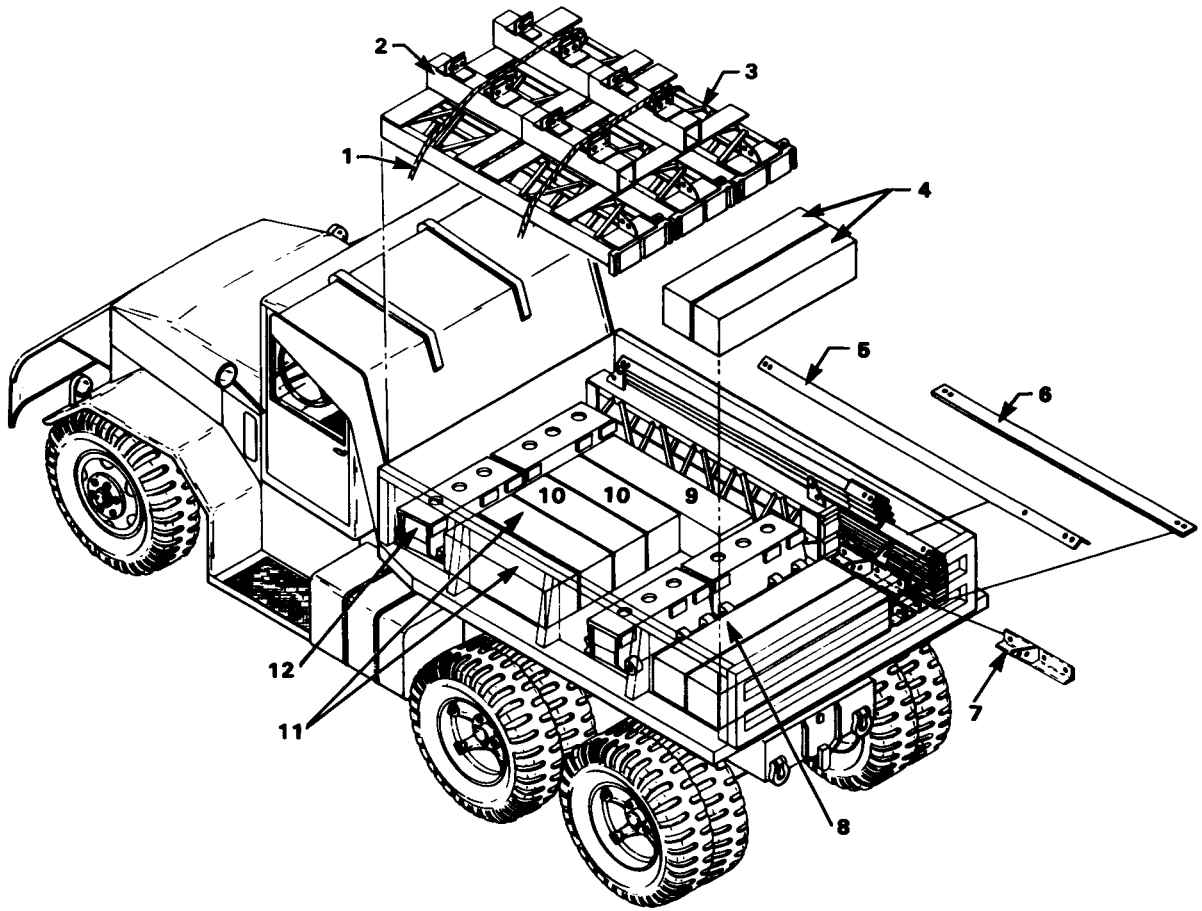


Figure 15-5 ***Set assemblies and components*** *(excluding cable reels, cable-reel supports, cable-reel shafts, and span junction posts)* ***stacked on body of any model of 5-ton tactical dump truck***

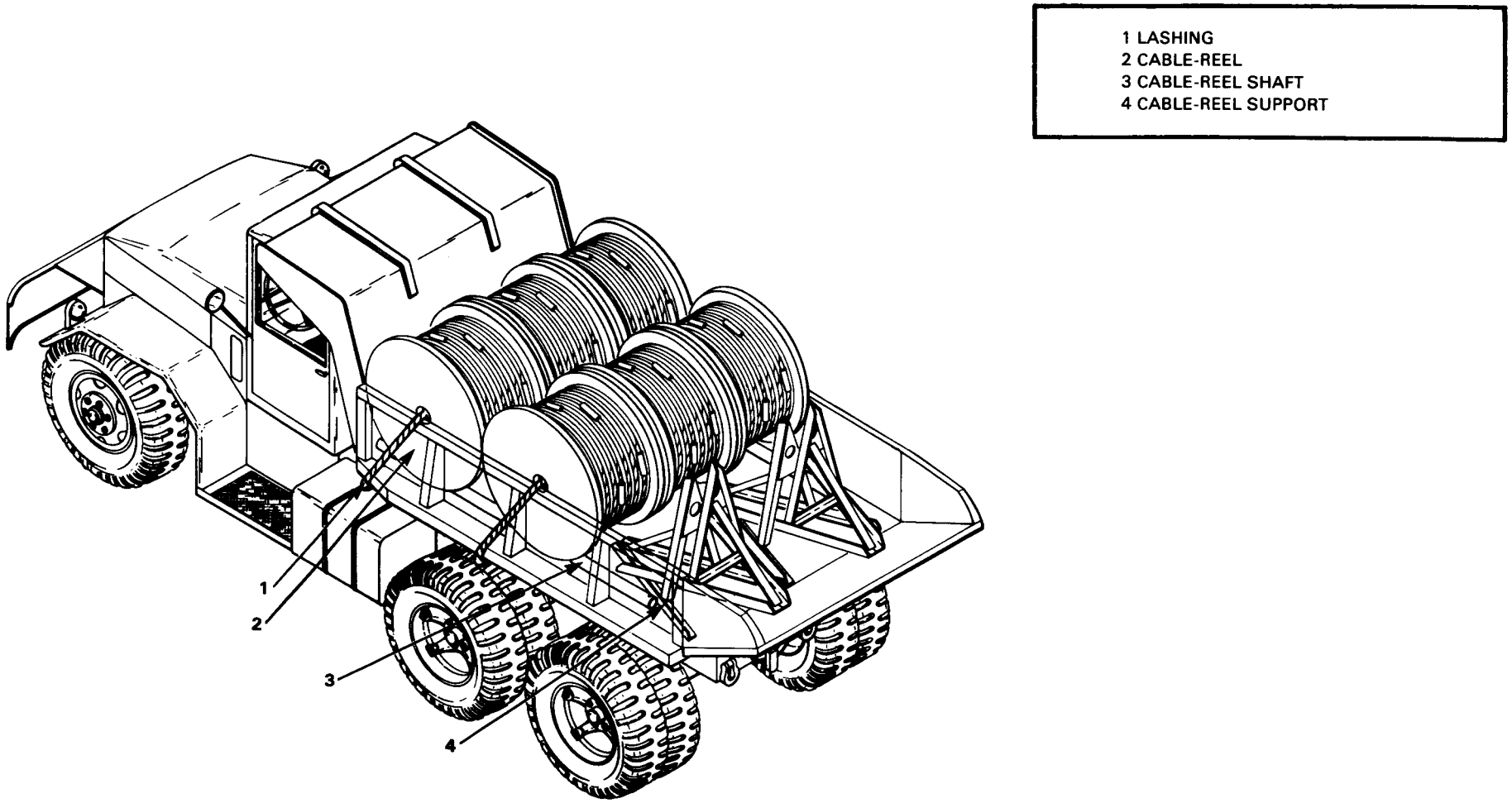


Figure 15-6 ***Cable reels, cable-reel supports, and cable-reel shafts stacked on body of any model of 5-ton tactical dump truck***

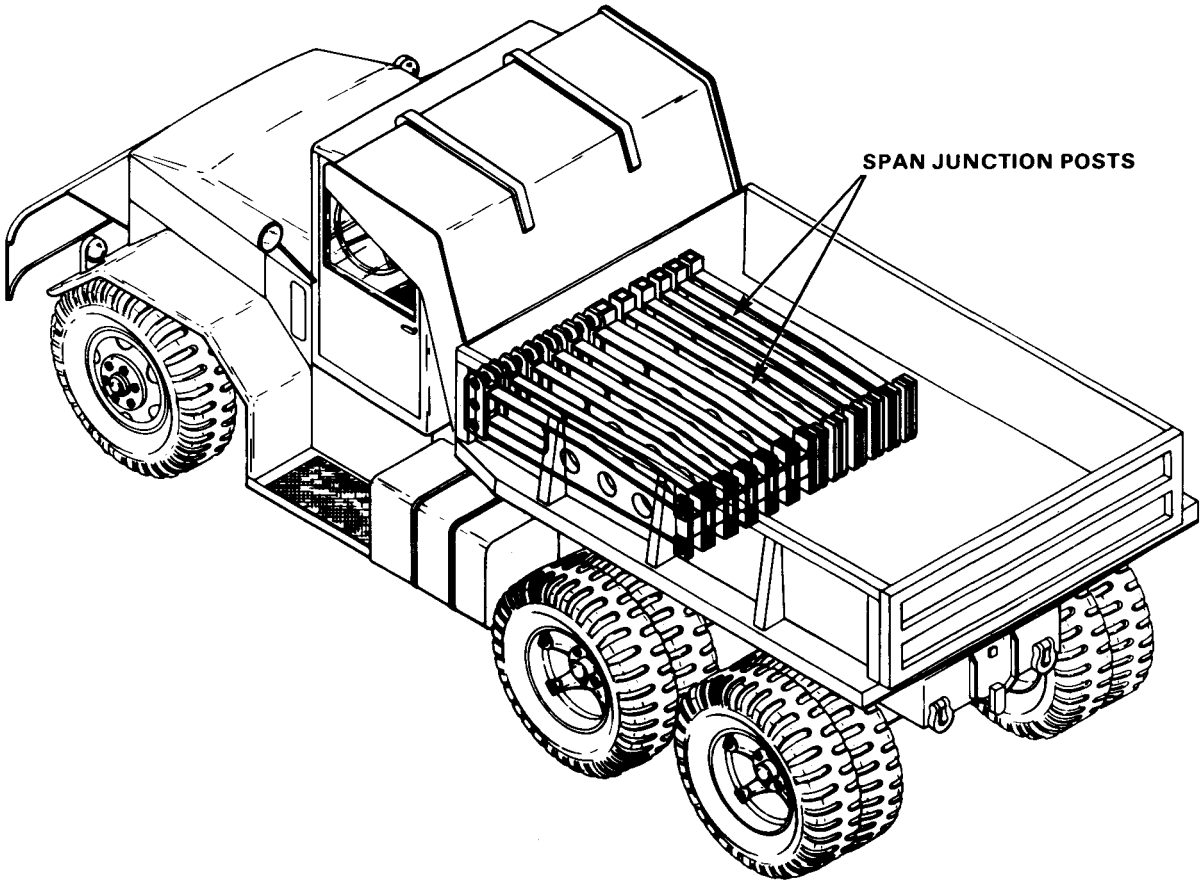
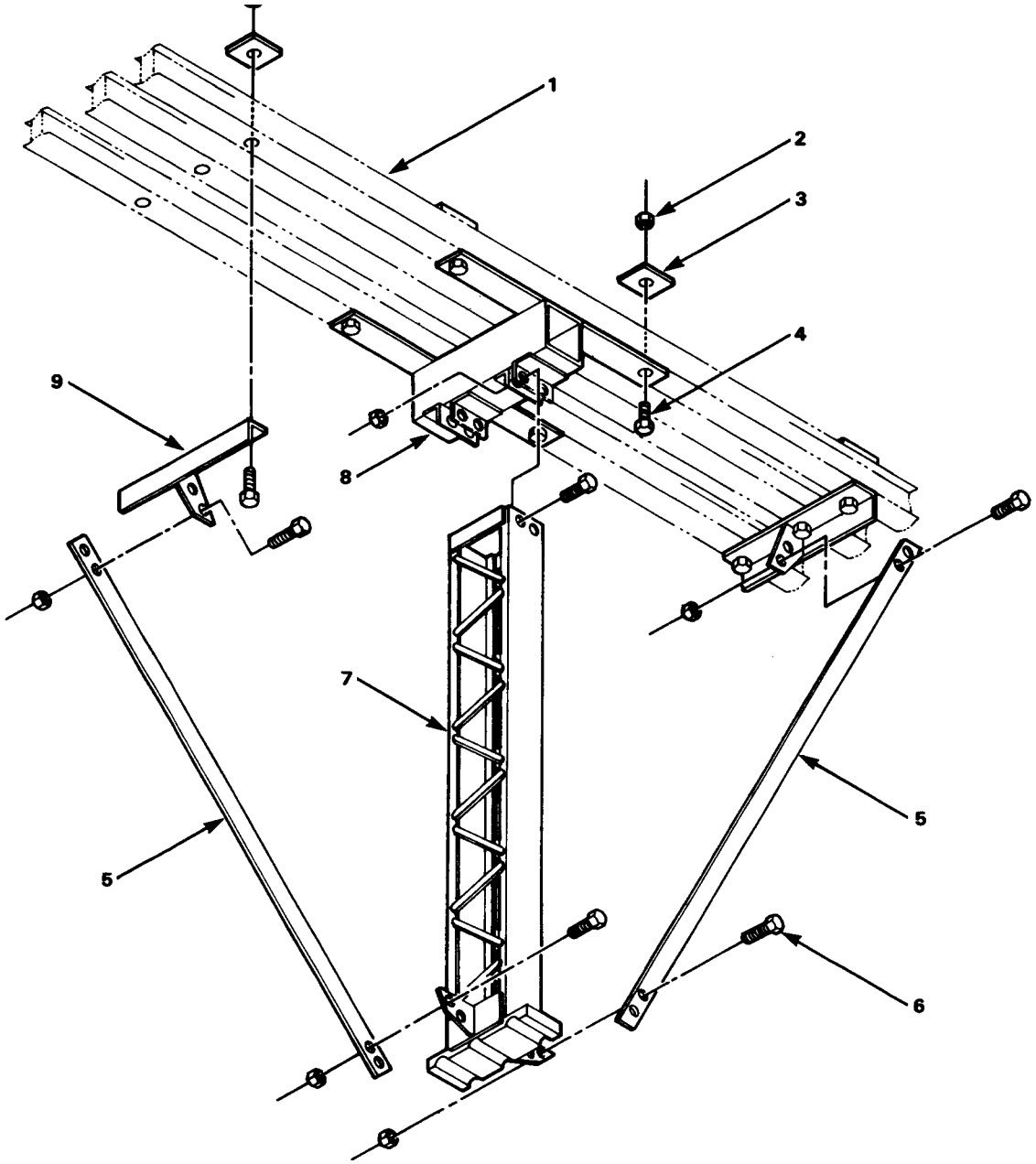


Figure 15-7 ***Span junction posts stacked on body of any model of 5-ton tactical dump truck***

COMPONENTS



DESCRIPTION

The following assemblies and components comprise the cable reinforcement set. Description of these parts includes function and location.

POST ASSEMBLY

The vertical-post assembly is a fabricated structural steel member suspended directly below a vertical member of the bridge panel. A saddle welded on the lower end of the vertical post provides a seat for the cables, and a cable retainer is bolted to the base to support the cables before they are tensioned. The post assembly is secured to the lower panel chord of the M2 Bailey bridge by the post-connection fixture (Figure 15-8). The post assembly weighs 269 pounds (122.3 kilos).

1 PANEL LOWER CHORD
2 HEX NUT
3 CHORD PLATE
4 CHORD BOLT
5 LONGITUDINAL BRACE
6 HIGH STRENGTH BOLT
7 POST ASSEMBLY
8 POST-CONNECTION FIXTURE
9 BRACE-CONNECTION FIXTURE

Figure 15-8 ***Vertical-post, brace-connection fixtures, and longitudinal braces secured to panel lower chord of M2 panel bridge***

POST-CONNECTION FIXTURE

The post-connection fixture (Figure 15-9) connects the post assembly with the bridge panel lower chord (Figure 15-8). Secure this fixture to panel lower chord by four bolts and hex nuts. Use two chord plates on one side of connection fixture to adapt bridge panel for securing fixture. The fixture weighs 178 pounds (80.9 kilos).

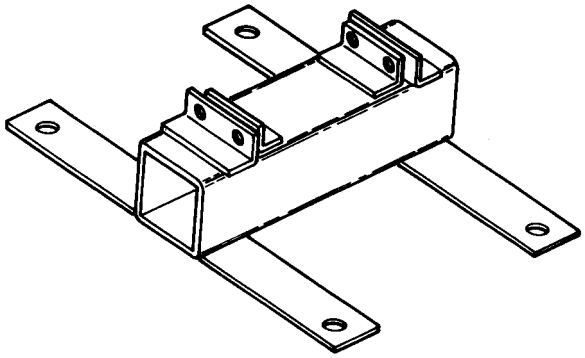


Figure 15-9 ***Post-connection fixture***

BRACE-CONNECTION FIXTURE

Left-hand and right-hand brace-connection fixtures (Figure 15-10) secure braces, which support the post assembly, to lower chord of bridge panel. Secure one brace-connection fixture to panel lower chord by three bolts and hex nuts. Secure the opposite brace connection by the same hardware plus addition of chord for securing this brace-connection fixture. The fixture weighs 32 pounds (14.5 kilos).

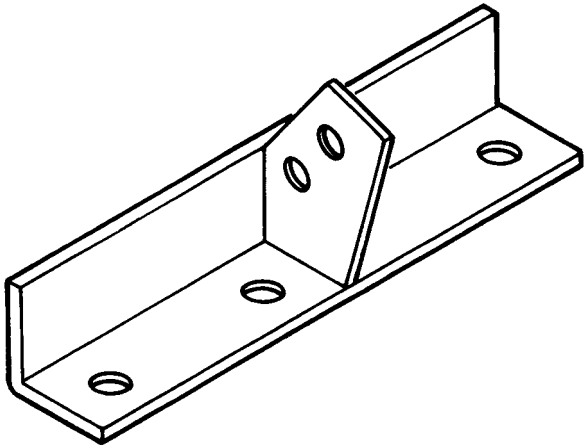


Figure 15-10 ***Brace-connection fixture***

BRACES

There are two types of post braces, longitudinal and transverse (Figure 15-11). The longitudinal braces are flat steel bars bolted to the brace-connection fixtures and the lower end of the post assembly (Figure 15-8). They are 8 feet ¼ inch (2.5 meters) long, 3 inches (7.6 centimeters) wide, 3/8 inch (1 centimeter) thick, and weigh 32 pounds (14.5 kilos) each. Transverse braces are steel angles which are placed between posts on each side of the bridge (Figure 15-12). These braces are bolted to welded plates on each end of the vertical post. For convenience of storage and transportation, each transverse brace consists of two parts: a 7-foot 4-inch (2.3 meters) brace angle with a welded splice plate on one end, and a 10-foot (3.1 meters) brace angle bolted to the splice plate of the shorter bracing. A high-strength bolt and hex nut secure the two transverse braces together where they cross between post assemblies (Figure 15-12). The total weight of one transverse brace is 88 pounds (40 kilos).

CHORD PLATE

The chord plate (Figure 15-13) is used to adapt the bridge panel lower chord for securing the brace-connection fixture and post-connection fixture to the panel lower chord.

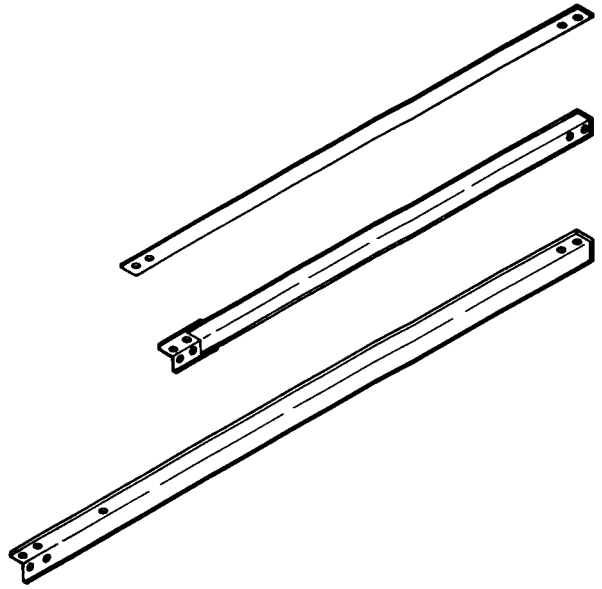
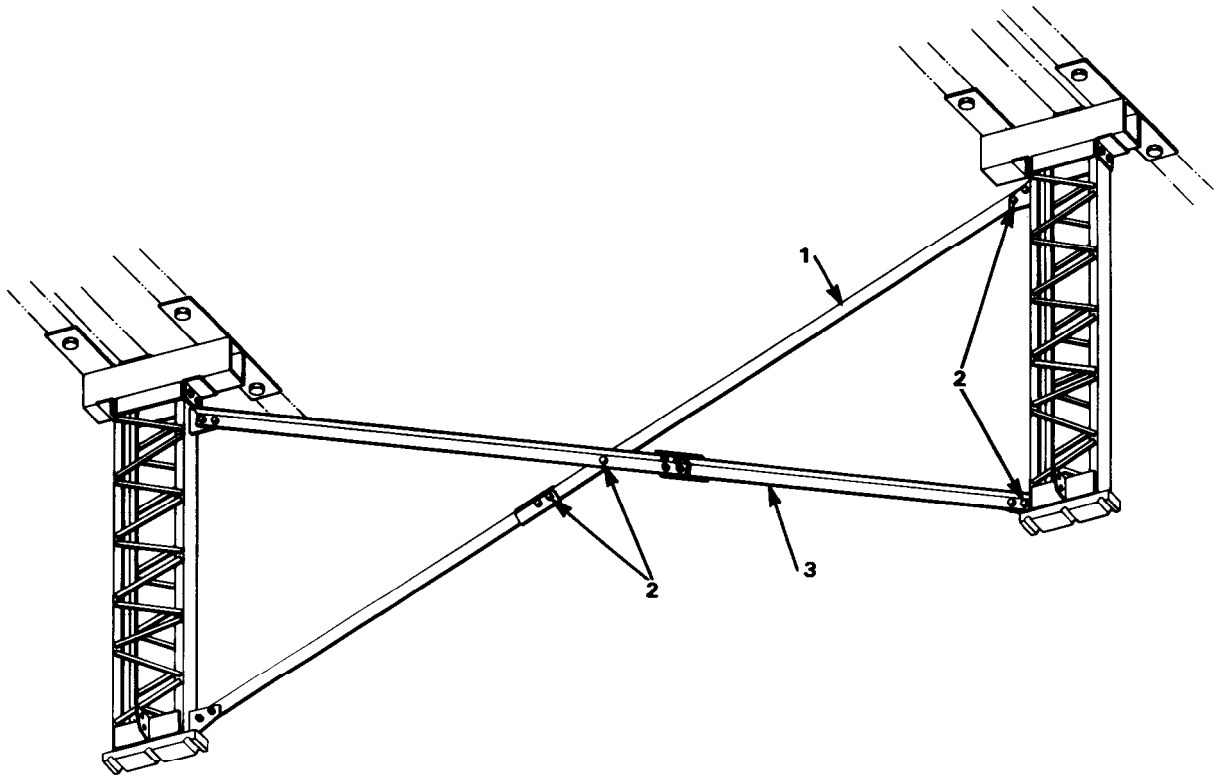


Figure 15-11 ***Longitudinal and transverse braces***

CABLE ASSEMBLY

The cables are 1¼-inch (3.2 centimeters) diameter high-strength wire ropes with threaded stud on one end and nine buttons at specific intervals along the cable length. The first button is about 100 feet (30.8 meters) from the stud end of the cable and the remaining eight buttons are spaced at approximately 10-foot (3. 1 meters) intervals toward the opposite end. Each button is marked with the applicable length of the M2 panel bridge. Screw stud end of cable into a rod-to-cable coupling (Figure 15-14, page 170) and secure by a bolt-type setscrew. The rod-to-cable coupling also has internal threads to retain the pull rod. The cables are 179 feet 6 inches (55.2 meters) long and weigh 595 pounds (270.5 kilos). They are wound on wooden



1 LONG TRANSVERSE BRACE
2 HIGH-STRENGTH BOLT ¾" DIAM
3 SHORT TRANSVERSE BRACE WITH WELDED SPLICE PLATE

Figure 15-12 ***Transverse braces***

cable reels for convenience of storage and shipping. The reels weigh 180 pounds (81.8 kilos) each. Six cables come with the reinforcement set.

CABLE REEL SUPPORTS

The cable reel supports (Figure 15-15, page 171) are steel frames that support a cable reel shaft on which three cable reels are retained.

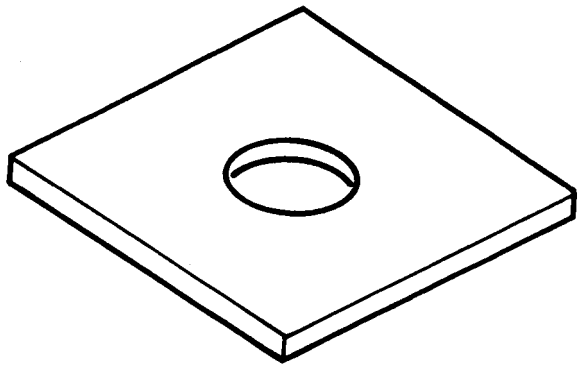


Figure 15-13 ***Chord plate***

Secure cable reel shaft to each cable reel support by a bolt inserted through each end of the pipe shaft and secure bolt by a nut. The cable reel support and cable reel shaft together weigh 287 pounds (130.5 kilos). The shaft is 10 feet (3.1 meters) long.

CABLE-CONNECTION BEAM

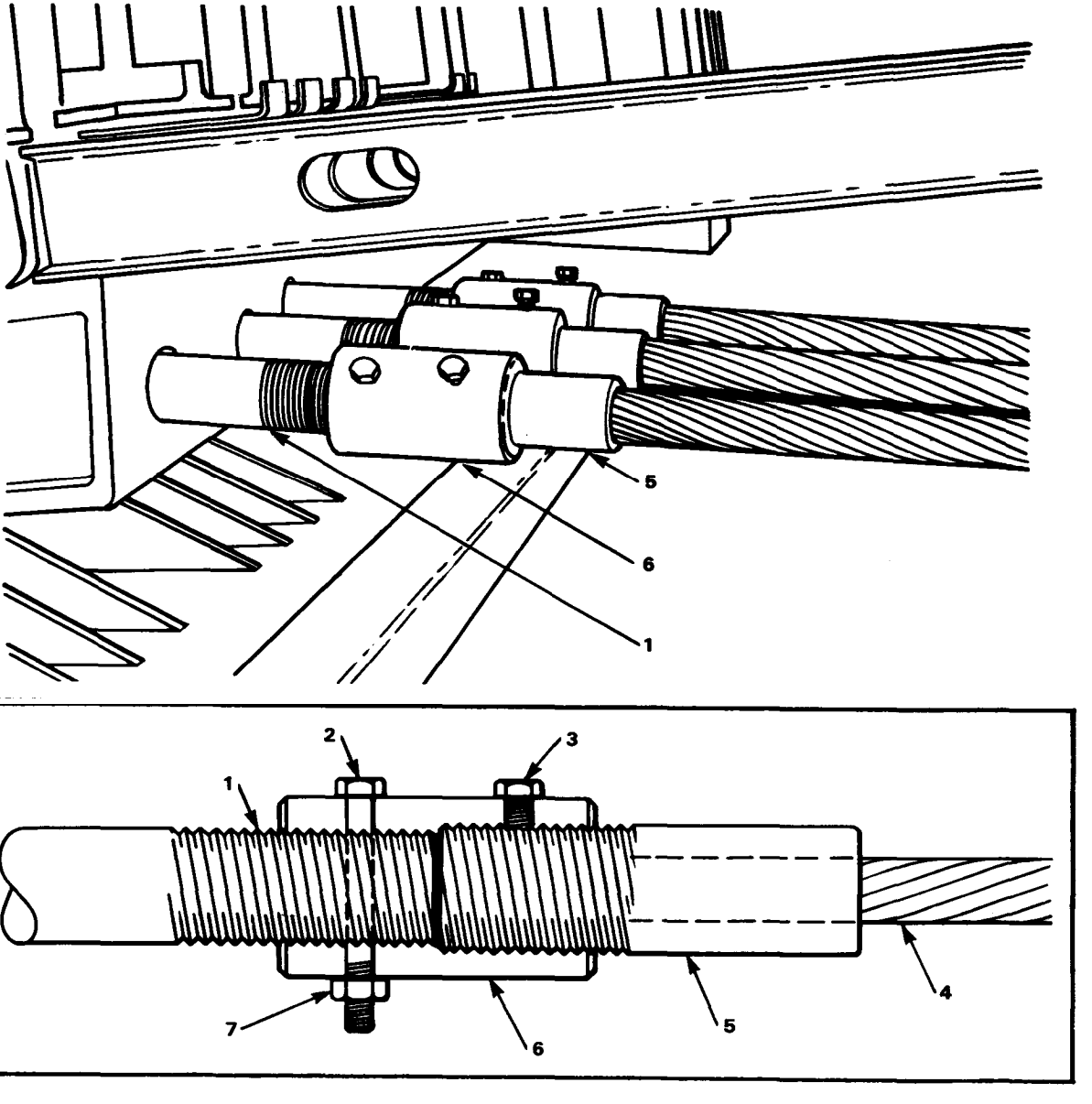
Left-hand and right-hand cable-connection beams (Figure 15-16, page 171) are steel frames secured to each corner of the M2 panel bridge for connection and tensioning of cables. Pin these components to bottom of span junction posts which replace end posts of M2 panel bridge. Each cable-connection beam is a frame, with provisions for three cables with buttons or pull rods to pass through it. The cable-connection beam weighs 315 pounds (143.2 kilos). These beams serve two purposes:

- They serve as a dead-end cable-connection beam. After inserting the cables, with buttons, through the holes provided in the

cable-connection beam, place half-cable retainers (Figure 15-17) between the bearing surface and the button to anchor the cable (Figure 15-18).

- They serve as a tensioning-end cable-connection beam. After connection to the rod-to-cable couplings, feed pull rods through the cable-connection beam and retain them by serrated nuts (Figure 15-19, page 172).

A double-acting hydraulic cylinder, when installed on each pull rod, bears against the front surface of the cable-connection beam through the use of an adapter (Figure 15-20). Use the double-acting hydraulic cylinders to tension cables (Figure 15-21).



1 PULL ROD
2 BOLT
3 BOLT-TYPE SETSCREW
4 CABLE
5 STUD END OF CABLE
6 ROD-TO-CABLE COUPLING
7 HEX NUT

Figure 15-14 ***Cable stud end and pull rod in rod-to-cable coupling, secured by bolt and nut*** *(shown in inset)*

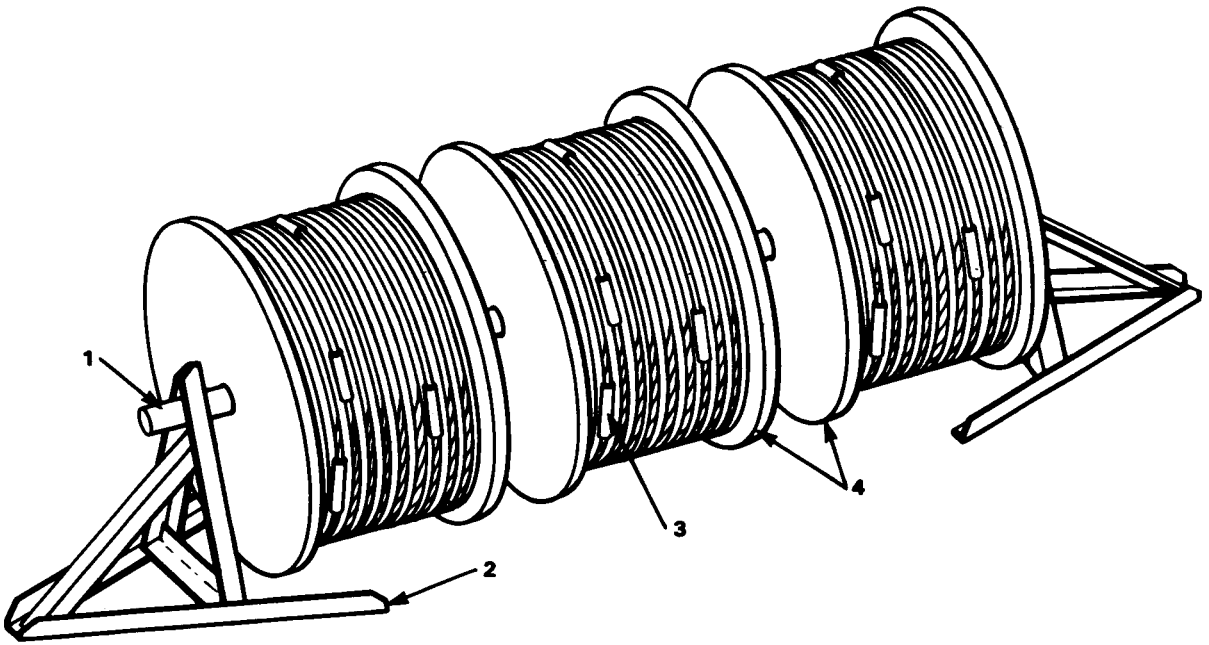


Figure 15-15 ***Cable assemblies installed on cable reels, with cable-reel supports***

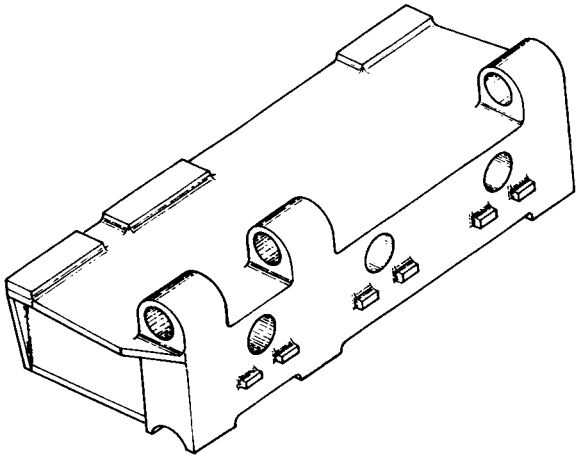


Figure 15-16 ***Left-hand cable-connection beam***

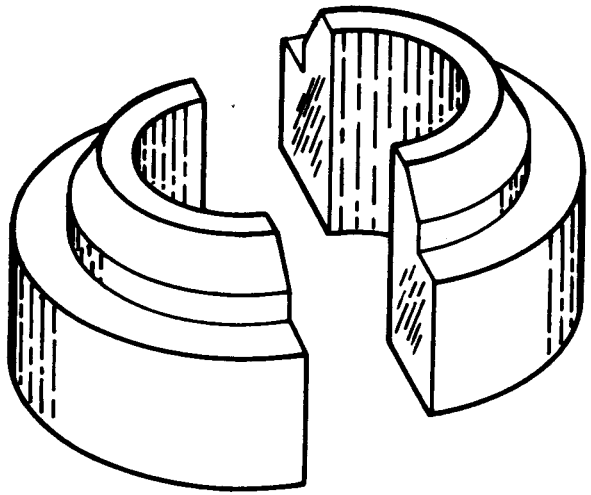


Figure 15-17 ***Half-cable retainers***

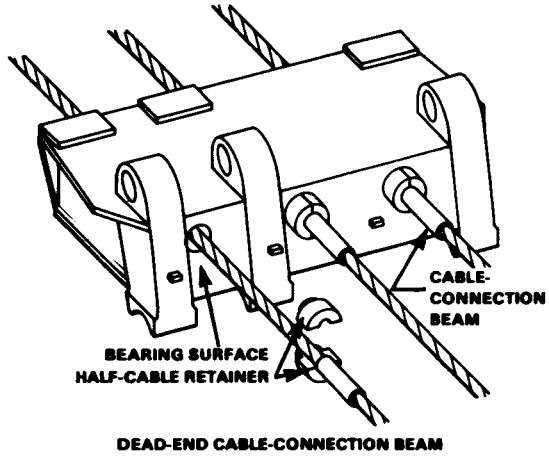


Figure 15-18 ***Half-cable retainers placed between the cable-connection bearing surface and the cable buttons***

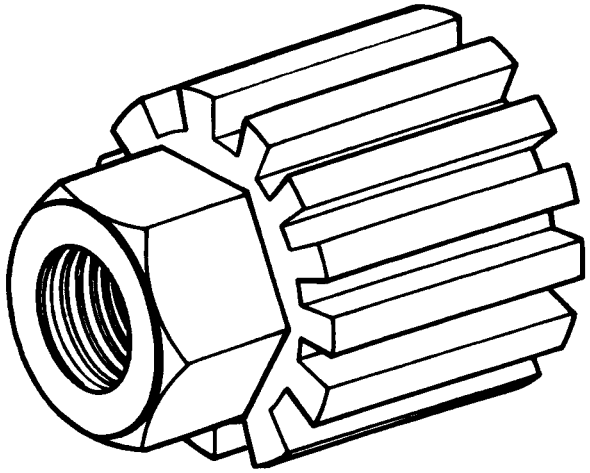
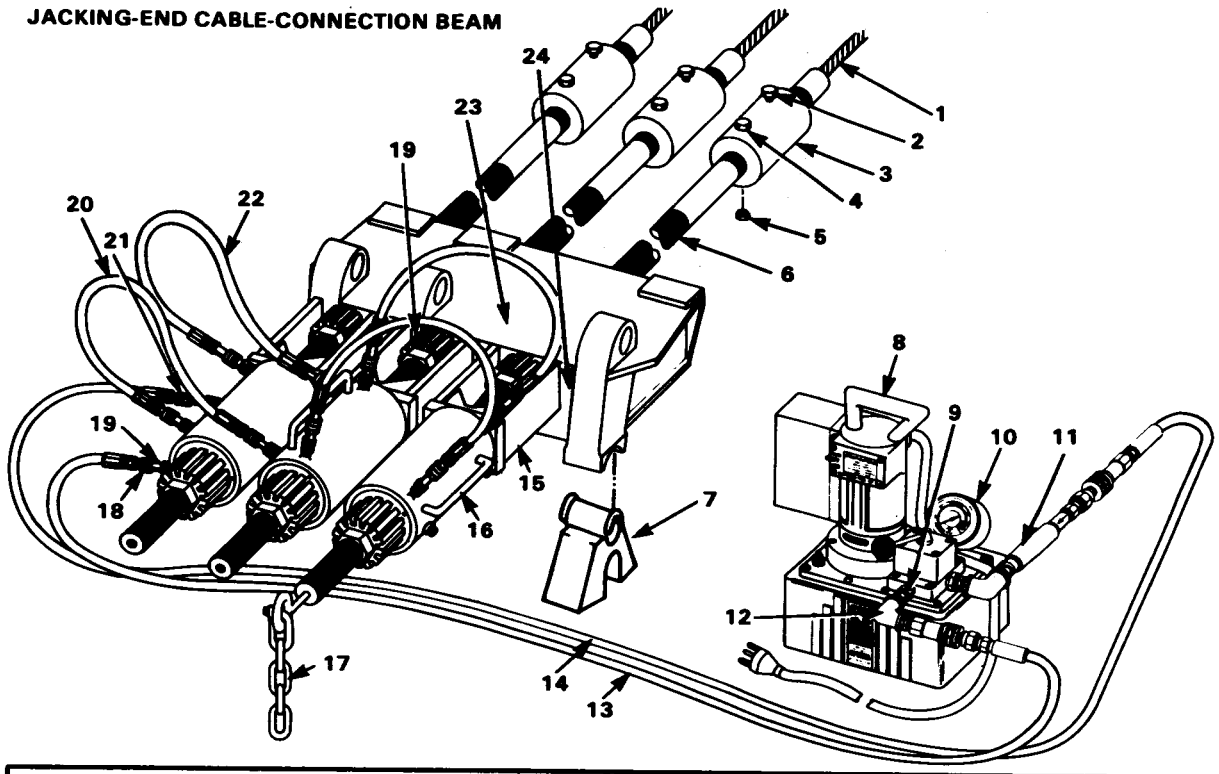


Figure 15-19 ***Serrated cable-cylinder nuts***



1 CABLE ASSEMBLY
2 BOLT-TYPE SET SCREW
3 ROD-TO-CABLE COUPLING
4 BOLT, 4½" LONG
5 HEX NUT, ½" DIAM
6 PULL ROD
7 BRIDGE-SEAT ROCKER (TENSIONING END ONLY)
8 HYDRAULIC POWER UNIT
9 BUSHING
10 DIAL-INDICATING CABLE-TENSION GAGE
11 FLOW REGULATOR
12 90° ELBOW
13 HOSE ASSEMBLY (LONG), MALE
14 HOSE ASSEMBLY (LONG), FEMALE
15 ADAPTER
16 DOUBLE-ACTING HYDRAULIC CYLINDER
17 PULL-ROD CHAIN
18 QUICK-DISCONNECT COUPLING (MALE)
19 CYLINDER NUT
20 HOSE ASSEMBLY (SHORT), MALE
21 QUICK-DISCONNECT COUPLING (FEMALE)
22 HOSE ASSEMBLY (SHORT), FEMALE
23 CABLE-CONNECTION BEAM
24 BEARING SURFACE

Figure 15-20 ***Cylinders installed on pull rods passing through cable-connection beam***

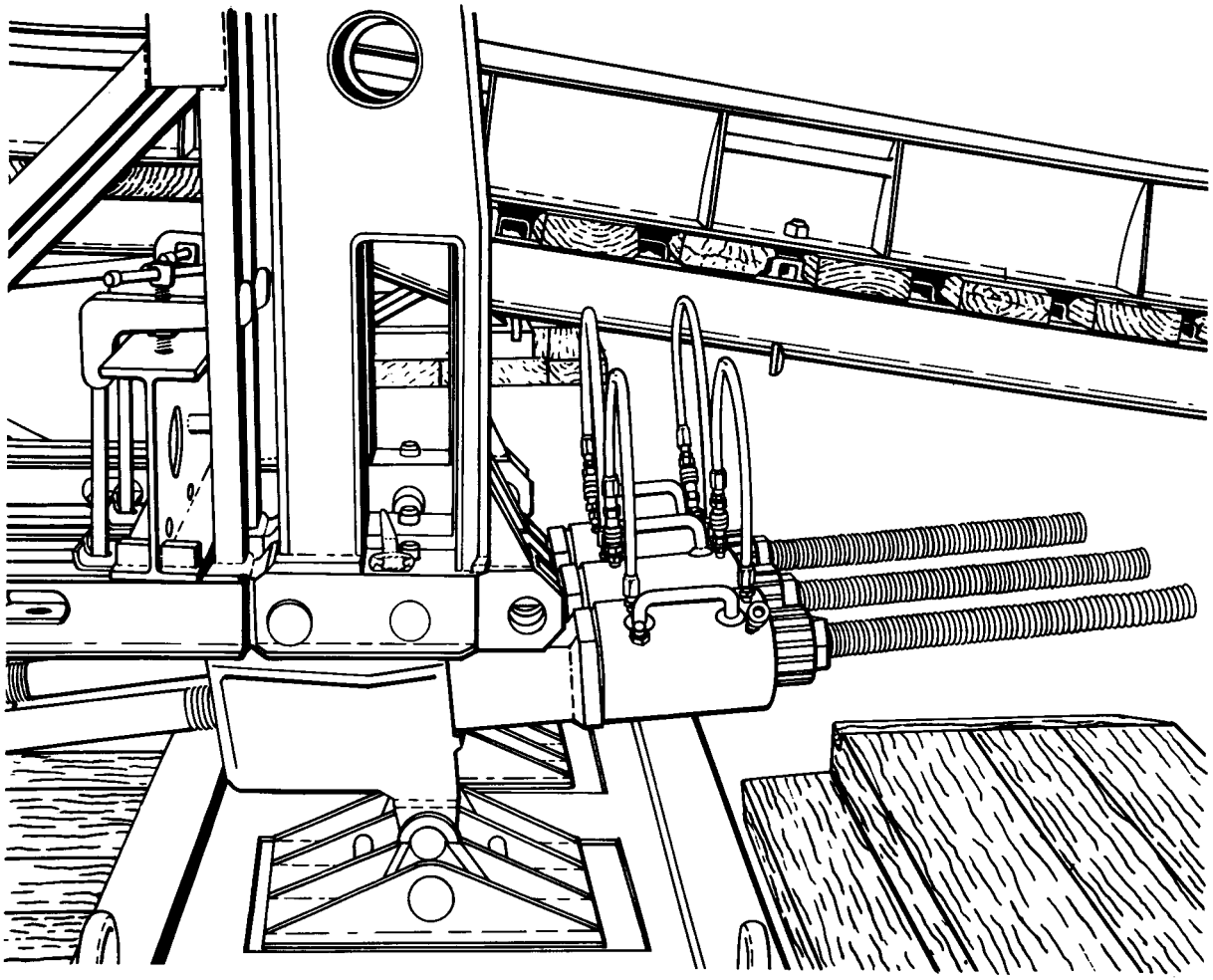


Figure 15-21 ***Double-acting hydraulic cylinders mounted on pull rods***

BRIDGE SEAT ROCKERS

Bridge seat rockers (Figure 15-22) are placed between the bridge bearing and the cable-connection beam at the tensioning end only (Figure 15-23, page 174). These rockers provide for longitudinal displacement that occurs while heavy traffic is crossing the bridge. Each rocker weighs 15 pounds (6.8 kilos).

PULL-ROD ASSEMBLY

The pull-rod assembly (Figure 15-24, page 174) consists of a 2¼-inch (5.7 centimeters) high-strength threaded rod, a rod-to-cable coupling, and two serrated nuts. The assembly provides for the connection of the cable to the cable-connection beam on the tensioning end and serves as a means to

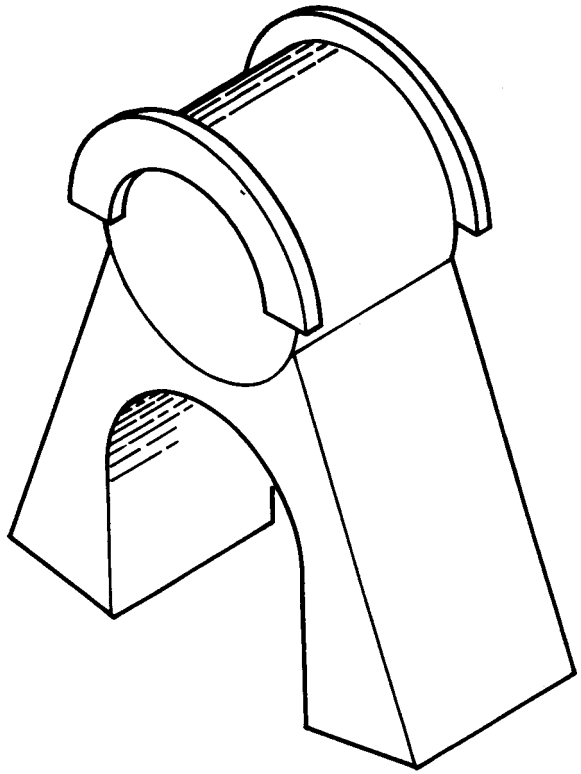


Figure 15-22 ***Bridge-seat rocker***

tension the cables. Thread one end of pull rod into one end of rod-to-cable coupling. Secure pull rod and rod-to-cable coupling by bolt and nut (Figure 15-14). When the cable is tensioned, a serrated nut bears against the bearing surface of the cable-connection beam to take cable-tensioning loads. The second serrated nut retains the double-acting hydraulic cylinder when it is installed on the pull rod. The two serrated nuts are identical. The nut used to retain the cable is called the cable nut and the nut used to retain the double-acting hydraulic cylinder is called the cylinder nut. The pull-rod assembly is 5 feet 10 inches (1.8 meters) long and weighs 60 pounds (27.3 kilos).

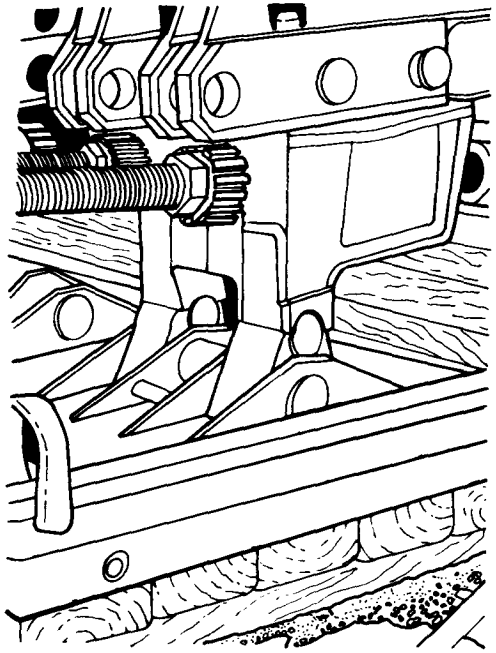


Figure 15-23 ***Bridge-seat rockers in place between standard bearing and cable-connection beam (tensioning end only)***

PULL-ROD CHAIN

The pull-rod chain (Figure 15-20) is 12 feet (3.7 meters) long and is screwed into the end of the pull-rod assembly after installation of pull rods in the cable-connection beam. This pull-rod chain helps to advance the cable nut before installation of hydraulic cylinders.

ADAPTER

An adapter (Figure 15-25) is used during the cable-tensioning procedure to take the cable-tensioning load from the hydraulic cylinder until the cable nut is tightened. Use one adapter for each cable. The adapter weighs 20 pounds (9.1 kilos).

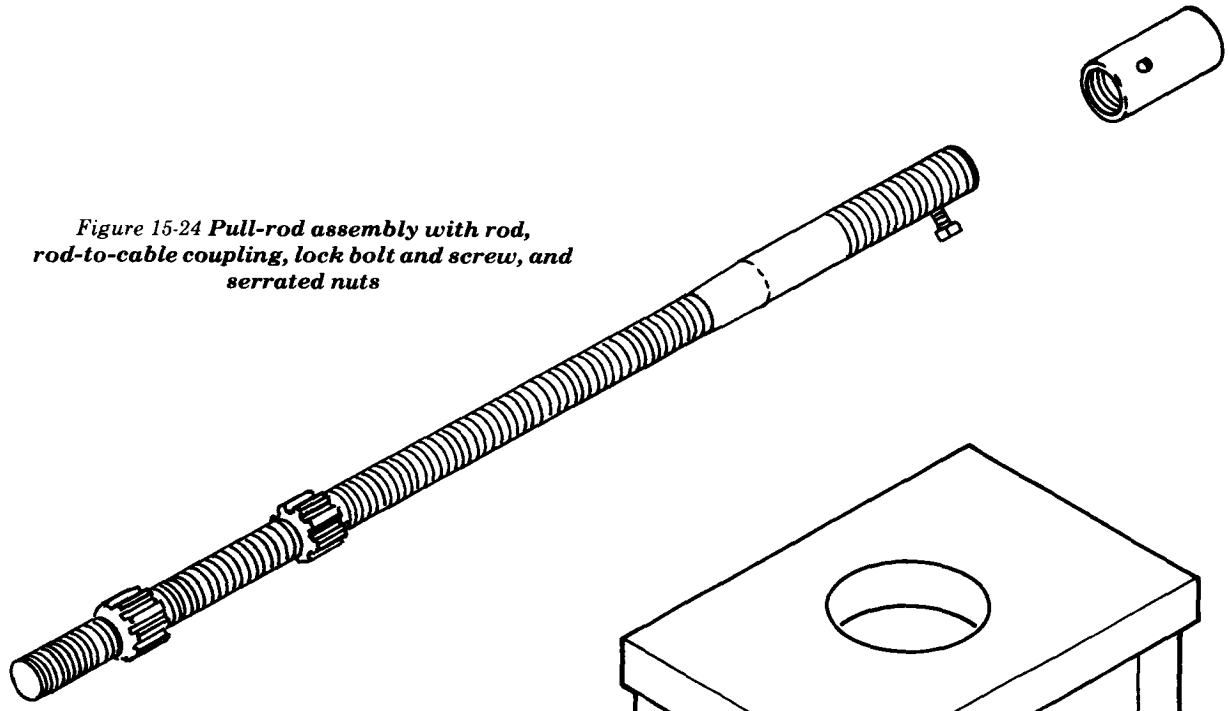


Figure 15-24 ***Pull-rod assembly with rod, rod-to-cable coupling, lock bolt and screw, and serrated nuts***

CABLE-TENSIONING ASSEMBLY

The cable-tensioning assembly is used to tension the cables. It has two basic components: a hydraulic power unit asembly, and double-acting hydraulic cylinders.

The hydraulic power unit assembly consists of a hydraulic power unit gage, hose assemblies, quick-disconnect couplings, and a flow regulator. The hydraulic power unit has a filler/vent plug for adding or removing hydraulic oil, an electric switch for controlling the amount of fluid flow, and a valve for controlling the direction of fluid flow. Two hydraulic power units are required for a

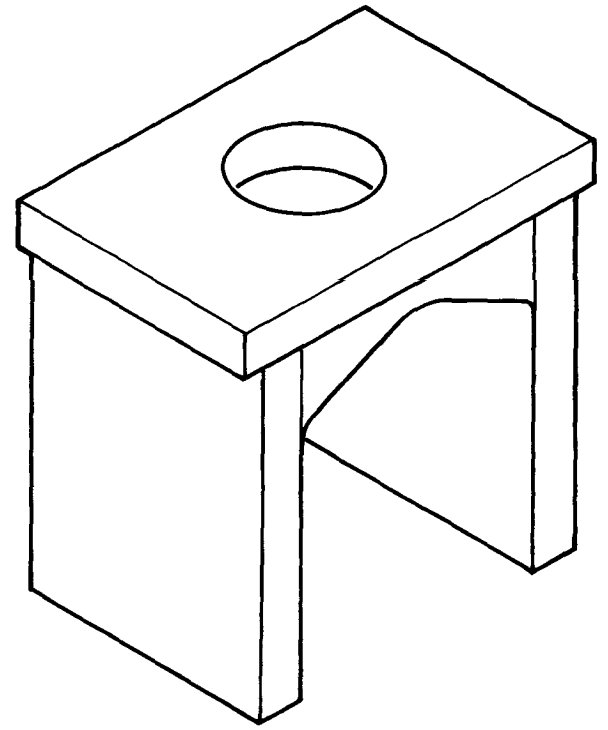


Figure 15-25 ***Adapter against which double-acting hydraulic cylinders bear during tensioning of the cables***

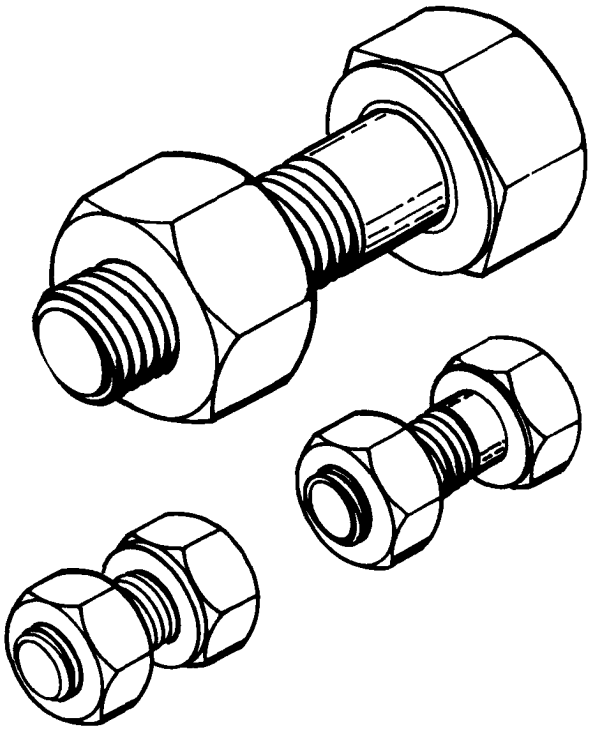


Figure 15-26 ***Bolts in cable reinforcement set***

bridge. Each weighs 65 pounds (29.5 kilos). They are powered by either one 10-kilowatt generator or two 5-kilowatt generators.

One double-acting hydraulic cylinder (Figure 15-21) is required for each cable. A hole through the center of the cylinder allows installation of the cylinder on the pull rod. The power unit is used to expand and retract the cylinders. When the cylinder is pressurized to expand, it advances the pull rod through the cable-connection beam, increasing cable tension. Each cylinder weighs 65 pounds (29.5 kilos).

HYDRAULIC RAM PUMP

The hand-driven hydraulic ram pump (Figure 15-4) is included in the kit to provide a means for periodic checking and adjusting of cable tension. It has an end dipstick/plug for checking and adjusting fluid level, a gage adapter, gage, hose assemblies with quick-disconnect couplings, flow regulator, and a control valve to direct fluid flow to and from the cylinders.

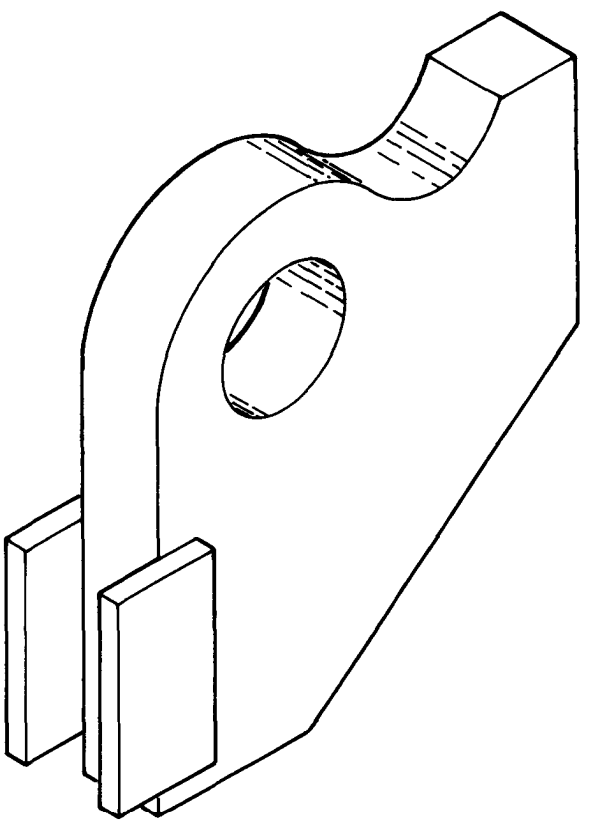


Figure 15-27 ***Jacking lug in cable reinforcement set***

BOLTS

Three types of bolts (Figure 15-26) are used to secure major parts of the cable reinforcement set together and to the M2 panel bridge: machine, chord, and high-strength bolts. Machine bolts secure parts in assemblies such as the cable reel shaft. Chord bolts secure fixtures to the panel lower chord. High-strength bolts secure bracings to the post assemblies. High-strength bolts are identified by radial lines embossed on the head.

JACKING LUG

Jacking lugs (Figure 15-27), when pinned to end holes of the span junction posts, provide a lifting surface for jacking up bridge.

SPAN JUNCTION POSTS

Male and female span junction posts (Figure 15-28, page 176) from bridge conversion set No. 3, Bailey type, panel crib pier, fixed M2 are used in place of the standard end post. The male post weighs 194 pounds (88.2 kilos) and the female post weighs 202 pounds (91.8 kilos).

BOX WRENCH

A special 2 5/8-inch (14.3 centimeters) box wrench (Figure 15-29, page 176) with offset head is used to tighten the chord bolts inserted through chord plates. After the nut is tightened as much as possible by normal means, use this wrench to tighten it another one-fourth turn by striking the end of the wrench with a sledgehammer.

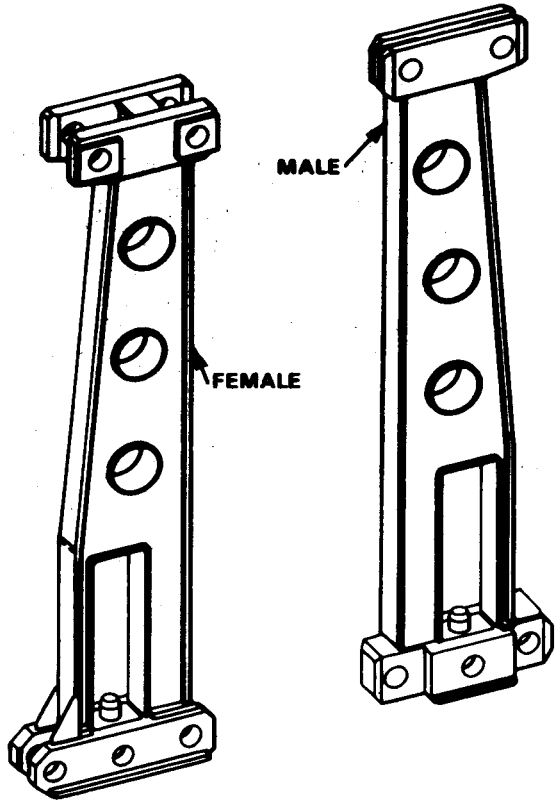


Figure 15-28 ***Span junction posts***

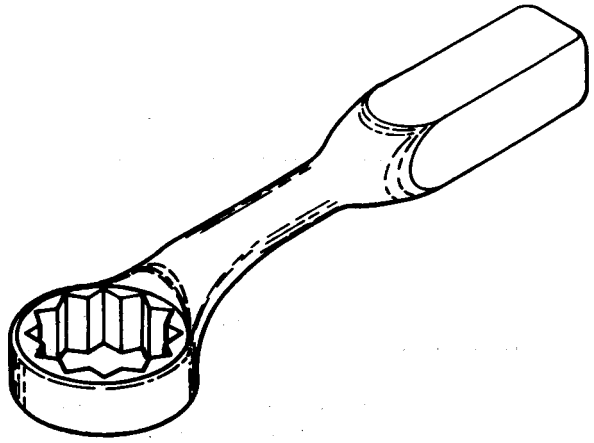


Figure 15-29 ***2⅝-inch box wrench used to tighten brace-connection fixtures to panel chords***

INSTALLATION AND DISMANTLING

SERVICE UPON RECEIPT

When new, used, or reconditioned material is first received by the using organization, make sure this material has been properly serviced by the supplying organization, and that it is in proper working condition. Keep records on any missing assemblies or component parts and equipment. Perform the following inspections and services for the cable reinforcement set before any installation procedures:

- Remove any cushioning material or protective covers from packaged cable-tensioning assemblies and pull-rod assemblies.
- Perform preventive maintenance checks and services as required, in accordance with Table B-3, Appendix B.
- Inspect cable-tensioning assembly for any leakage or damage which would limit effective operation.

USE WITH NEW BRIDGE

The cable reinforcement set can be used with both new and existing panel bridges. When used with a new bridge, it should be installed concurrently with assembly of the new bridge.

Placement of material

Install material before assembly of the bridge as follows:

1 Unload contents of trucks which carry all assemblies and component parts (except the cables and cable reels) and stack them in the vicinity of the end posts in the M2 panel bridge standard layout.

2 Place three cable reels with cables, which are retained on the cable reel supports, on each side of the roadway at rear of bridge erection site. Remove cable reels from bed of truck by using crane or gin poles.

To erect cable reel supports, place three unloaded cable reels side by side; insert cable reel shaft through center hole of cable reels; lift one end of cable reel shaft, close to cable reel; and slide cable reel support on cable reel shaft. Repeat for other end of cable reel shaft.

Post assembly

Attach post assemblies to the lower panel chords of the bridge according to Table 15-1. To install each vertical post, proceed as follows:

Caution: **In order to install a post assembly correctly, the post-connection fixture must be installed directly beneath the vertical member between two panels (from now on referred to as the panel point).**

1 When panel point has sufficiently cleared rocking roller, position post-connection fixture directly beneath panel point.

2 Secure post-connection fixture to bridge-panel lower chord using four l¾-inch (4.5 centimeters) diameter chord bolts and hex nuts. Tighten bolts firmly. Place bolts on one end of the post-connection fixture in holes normally used for adding second- or third-story tiers to Bailey bridge. Secure the other end by placing two chord plates on top of lower chords, using two 1¾-inch (4.5 centimeters) bolts and hex nuts.

3 When a point approximately 4 feet (1.2 meters) behind the panel point has cleared the rocking rollers, install brace-connection fixtures. Position large holes in brace-connection fixtures about 3 feet 9 inches (1.2 meters) ahead of and behind panel point. On one side, holes will lineup with holes in lower chord used for multi-story construction. Secure brace-connection fixture by placing chord bolts through these holes and tightening hex nuts. On the other side, use two chord plates and bolt through the panel lower chords. Place bolt with nut on top of chord plate. Tighten nut enough to secure brace-connection fixture but to allow for adjustment later.

4 When at least 8 feet (2.5 meters) of clearance is available below panel point, install vertical post. Remove cable retainer from vertical post and lower post over side of bridge using ¾-inch (1.9 centimeters) hemp rope. Secure vertical post to post-connection fixture, using four ¾-inch (1.9 centimeters) diameter high-strength bolts and hex nuts.

WARNING: All personnel who are lowered over the side of the bridge in a boatwain's chair must also wear a safety belt connected to a lashing which, in turn, is secured to the side of the bridge.

5 Secure one longitudinal brace to plate weldment of brace-connection fixture with two ¾-inch (1.9 centimeters) diameter high-strength bolts and hex nuts. Bolt opposite end of longitudinal brace to plate weldment on bottom end of vertical post, using two high-strength bolts and hex nuts (Figure 15-8).

6 Secure second longitudinal brace to plate on brace-connection fixture which is secured with chord plates, with two ¾-inch (1.9 centimeters) diameter high-strength bolts and hex nuts. Attach opposite end of brace to plate weldment on lower end of vertical post using the same hardware. A small adjustment in position of this longitudinal brace-connection fixture may be necessary to complete installation of the second longitudinal brace. Once brace-connection fixture is positioned, tighten chord bolts through chord plates using 2 5/8-inch (6.7 centimeters) box wrench having offset head. Turn nut on bolt threads one-fourth turn, from point where a person can no longer tighten bolt by applying hand pressure to wrench, by striking wrench with sledgehammer (Figure 15-30) to complete installation of longitudinal braces.

7 Connect long transverse brace to short transverse brace, which has a welded splice plate, with four ¾-inch (1.9 centimeters) diameter high-strength bolts and hex nuts to form full-length transverse brace. Repeat this procedure to form all full-length transverse braces. Connect two transverse braces to plates on each end of vertical posts to form X-type bracing. Secure each end of transverse braces to vertical post weldment plates by two ¾-inch (1.9 centimeters) high-strength bolts and hex nuts. Bolt the two transverse braces together where they cross by installing a ¾-inch (1.9 centimeters) diameter high-strength bolt and hex nut through the hole provided in the braces (Figure 15-12).

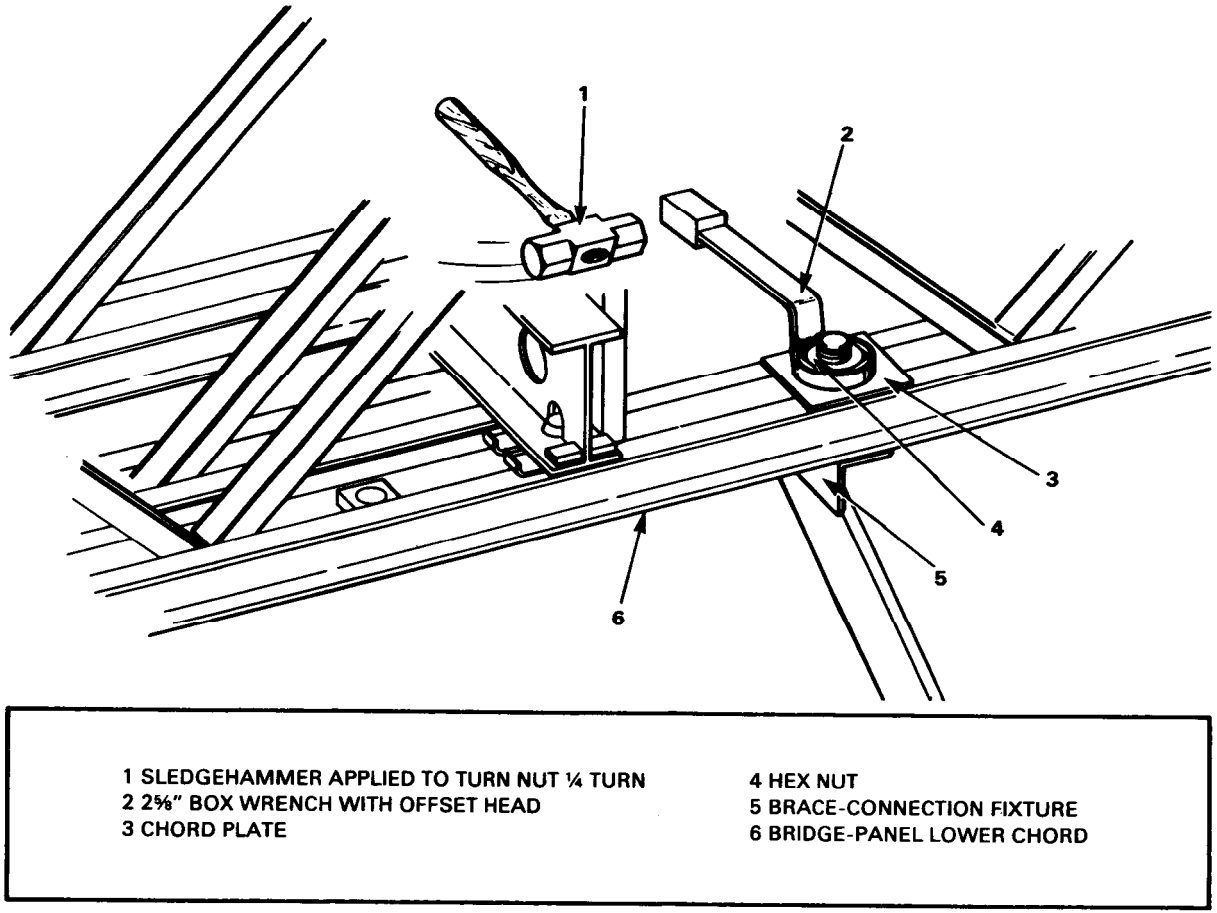
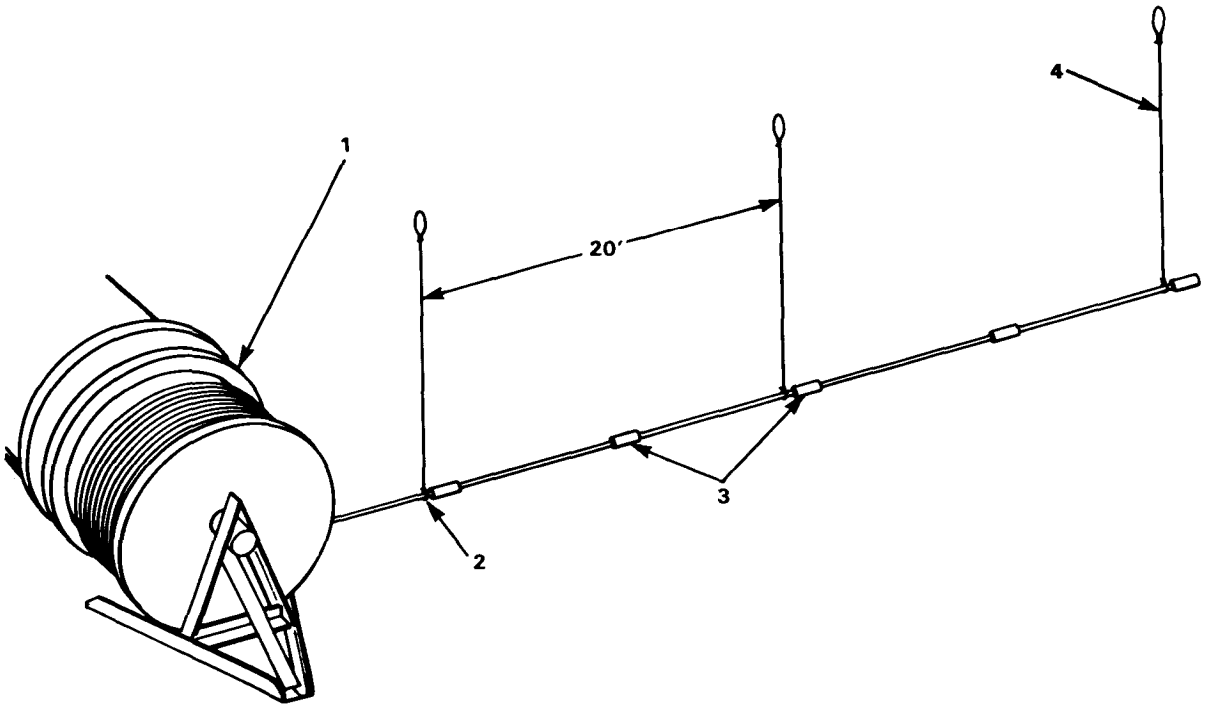


Figure 15-30 ***Sledgehammer applied to end of offset-head box wrench to tighten nut ¼ turn***

Caution: **This bolt provides a stabilizing function for the transverse braces. Do not forget to install it. Omission of this bolt could result in damage to the equipment.**



1 CABLE REELS AND CABLE SUPPORTS
2 CABLE PULLED FROM REEL AND LASHINGS SECURED TO CABLE AT 20′ INTERVALS
3 CABLE BUTTONS
4 16′ LASHING

Figure 15-31 ***Unwinding cable from cable reel and installing rope lashings***

Position of cables

The total number of cables used depends on the bridge span; Table 15-1 gives the number needed for various spans. Place the required cables in a preliminary position on the bridge structure before launching the bridge, using the following procedure:

1 Unwind one cable at a time from cable reels, button end first.

2 Loop 16-foot (4.9 meters) length of ¾-inch (1.9 centimeters) diameter hemp rope to cable at 2-foot (61.1 centimeters) intervals. Make a loop at each end of rope to facilitate carrying and lashing of cable (Figure 15-31). Using these ropes to support cable, carry cable onto bridge.

3 When cable button number 180 is at the panel which will be the end panel on far shore, lash cable to panels.

4 Repeat the three steps above for each cable on each side of bridge. If three cables are installed on each side of bridge, lash cable to be installed in inner slot of vertical-post saddle to lower part of bridge panels. Lash cable for center saddle slot to middle of panels and lash outside cable to top part of panels.

Span junction posts

Just before final positioning of the bridge, install female span junction posts on one side of the bridge. Then do as follows:

1 Insert a transom through holes in female span junction posts and push through hole until flange of transom hits side of female span junction posts.

2 Install female span junction posts on the other side.

3 Position the transom properly on studs of the six female span junction posts.

Bridge bearing plate

To position the bridge bearing plate, do as follows:

1 Position bridge so that centerline of first panel pin, through bottom of span junction post, measures 4 inches (10.2 centimeters) to centerline of outer rocking roller.

2 Place the back inside edge of the base plate about 18 inches (45.8 centimeters) behind centerline of first panel pin.

3 On tensioning end of bridge, place special bridge seat rocker (Figure 15-22) over each bearing to allow longitudinal displacement of bridge under load.

Note: When bridge is jacked down, bearing shoe on bottom of installed cable-connection beam will mate bearings on baseplate or rockers on bearings.

Jacking up of bridge

Jack up the bridge as follows:

1 Install two jacking lugs (Figure 15-27) at each bridge corner, one on end hole of outside span junction post and one on the end hole of inside span junction post, using panel pins (Figure 15-32).

2 Install railroad jacks and jack up end of bridge to ease installation of cable-connection beams.

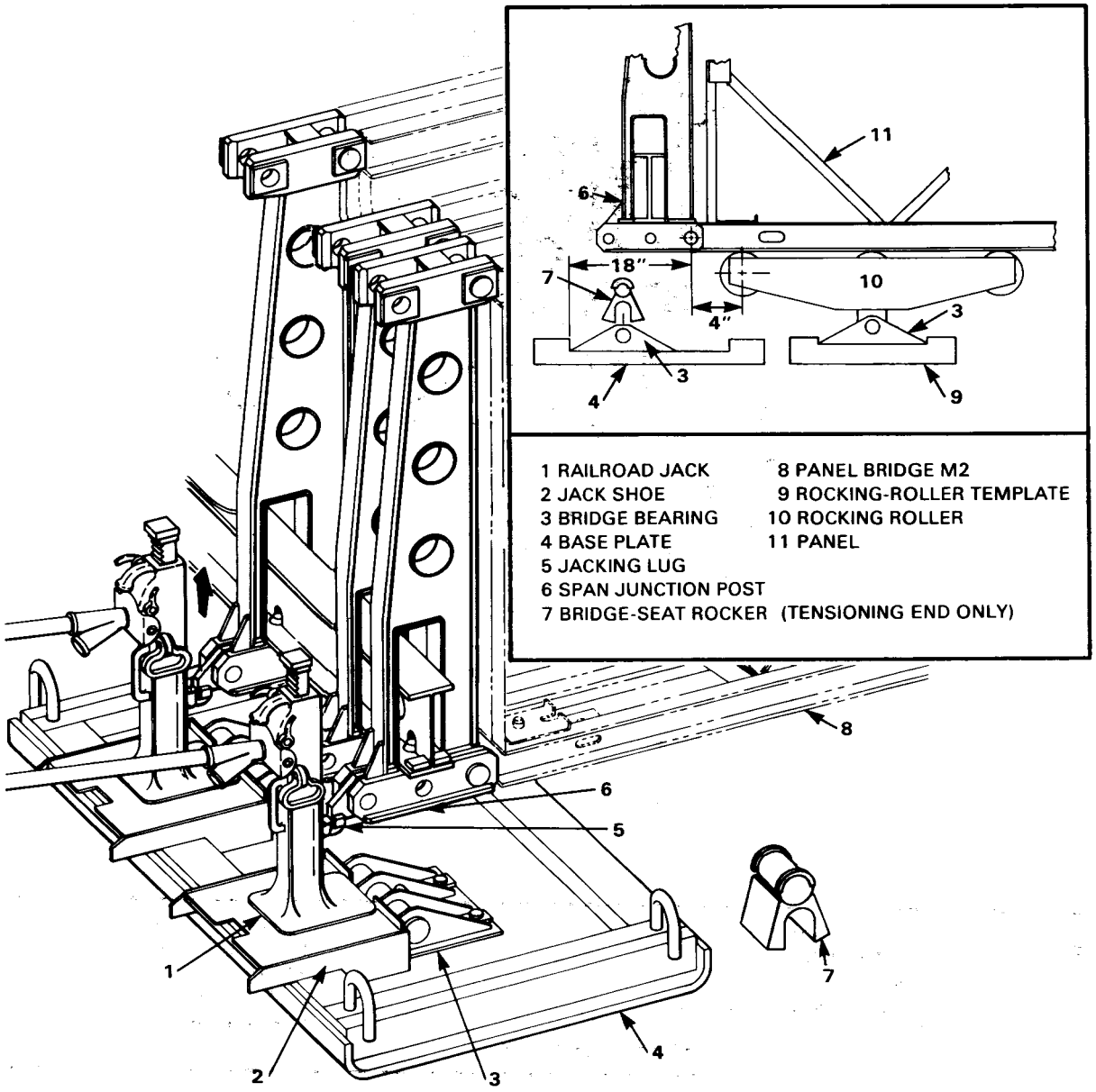
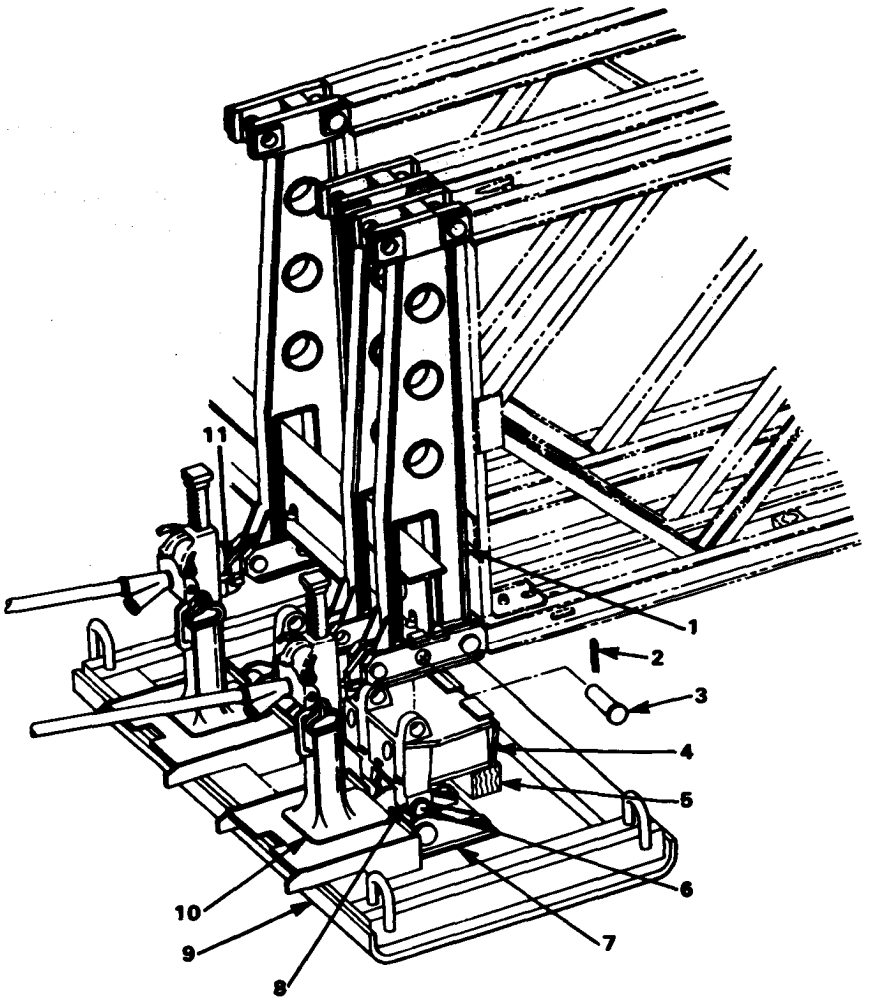


Figure 15-32 ***Jacking up end of M2 panel bridge to install cable-connection beam***



1 SPAN JUNCTION POST	7 BRIDGE BEARING
2 RETAINER, BRIDGE PIN	8 BEARING SHOE
3 PANEL PIN	9 BASE PLATE
4 CABLE-CONNECTION BEAM	10 RAILROAD JACK
5 BLOCKING	11 JACKING LUG
6 BRIDGE-SEAT ROCKER (TENSIONING END ONLY)	

Figure 15-33 Positioning cable-connection beam under span junction posts

3 Use normal bridge installation procedure for removal of rocking rollers and templates, and we cribbing under the lower chord for safety in case bridge slips off jacks.

Cable-connection beam

To install cable-connection beam, do as follows:

1 Position cable-connection beams on bridge seat rockers (tensioning end only) or bearings (dead end) under raised span junction posts.

2 Using normal jacking procedure, lower bridge onto cable-connection beams until holes in beam lugs align with lower center holes in span junction posts (Figure 15-33).

3 Secure the cable-connection beams to span junction posts using a set of standard panel pins, and secure panel pins with retainer clips.

4 Complete jacking bridge down onto the bearings (Figure 15-34, page 182) and continue with normal procedure for standard installation of the bridge.

Caution: **It is essential that both near- and far-shore abutment cribbings be level transversely with each other in order to eliminate eccentric loading causing bridge elements to be stressed beyond their capacity. It should also be noted that the bridge seat rockers will cause the tensioning end to be higher by the installed height of the rockers.**

Installation of cable

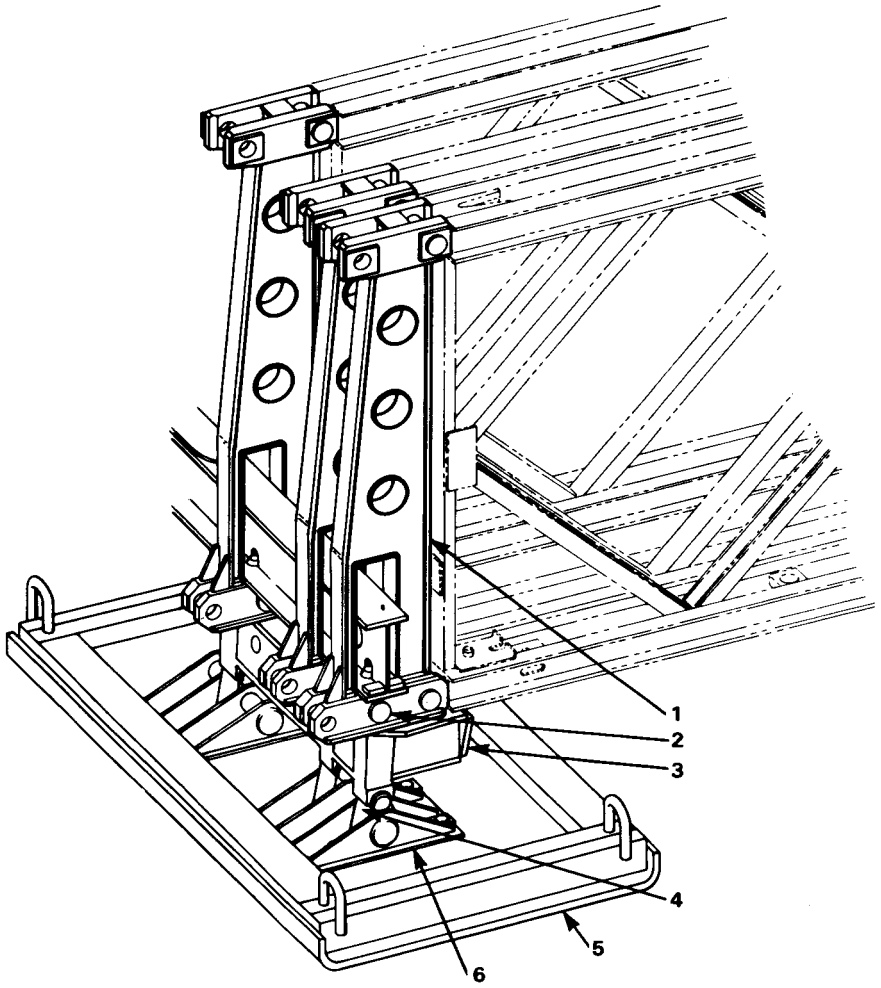
After the bridge has been decked, install all cables. Use the following procedure for each cable

1 Remove lashing ropes from side panels of bridge but not from cable.

2 Using the ropes to support the cable, thread button number 180 and the following cable through dead-end cable-connection beam. If only two cables are used, one on each side, thread each cable through center hole of cable-connection beam. If four cables are used, two on each side, no cable is threaded through center hole. Continue threading operation until cable button stamped with number corresponding to span length in feet has passed through cable-connection beam.

3 Place two half-cable retainers between button and cable-connection beam bearing surface (Figure 15-18) to prevent button from being pulled through cable-connection beam during cable tensioning.

4 At tensioning end of the bridge, remove cable and cylinder nuts from pull rod and thread pull rod into rod-to-cable coupling.



1 SPAN JUNCTION POST
2 PANEL PIN
3 CABLE-CONNECTION BEAM
4 BRIDGE-SEAT ROCKER (TENSIONING END ONLY)
5 BASE PLATE
6 BRIDGE BEARING

Figure 15-34 ***M2 Bailey bridge jacked down on bridge bearing plate***

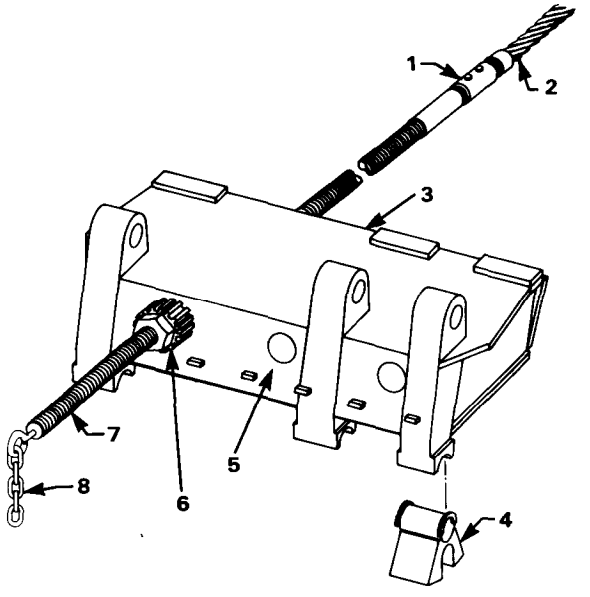

1 ROD-TO-CABLE COUPLING
2 CABLE
3 CABLE-CONNECTION BEAM
4 BRIDGE-SEAT ROCKER (TENSIONING END ONLY)
5 BEARING SURFACE
6 SERRATED CABLE NUT (THREAD 21" ON PULL ROD)
7 PULL ROD
8 PULL-ROD CHAIN

Figure 15-35 ***Cable nut retaining pull rod in cable-connection beam***

Continue turning pull rod until it bottoms in rod-to-cable coupling. Turn pull rod back one-half turn or more to align hole through pull rod and rod-to-cable coupling. Insert a 1/2-inch (1.3 centimeters) diameter bolt (inset, Figure 15-14) through the rod-to-cable coupling and pull rod. Install hex nut on end of bolt. Thread coupling onto stud end of cable until it bottoms. Insert a 1/2-inch (1.3 centimeters) diameter setscrew.

5 Feed pull rod through proper hole in cable-connection beam and retain with cable nut (Figure 15-35). Then advance cable nut so that pull rod extends beyond cable-connection beam at least 21 inches (53.4 centimeters). This may be done by threading the eyebolt on the 12-foot (3.7 meters) pull-rod chain into pull rod and pulling, advancing the cable nut as pull rod advances; by advancing pull rod using hemp rope tied to cable at or near rod-to-cable coupling; or by advancing cable nut using chord-bolt wrench.

6 Position cable below vertical posts and remove all rope lashings from cable.

Caution: **The cable must be guided into the correct slot of the vertical-post saddle by bridge personnel while the cables are being tensioned.**

7 Repeat the six steps above to install all cables on bridge. After cables are installed on both sides of bridge, secure each cable retainer to vertical-post saddle with four 1/2-inch (1.3 centimeters) diameter bolts and hex nuts.

USE WITH EXISTING BRIDGE

The procedures for installing the cable reinforcement set on an existing panel bridge, M2, are similar to those for a new bridge. Place the contents of the trucks carrying all assemblies and component parts on each side of the bridge as close to the area of installation as possible. Next, remove the cable reels from the trucks on the near shore and install on cable reel supports on each side of the roadway, close to the bridge.

Cable-supporting structures

Install the post-connection fixture, post cable assembly, brace-connection fixtures, and longitudinal and transverse braces like the installation for a new bridge and as follows:

1 Using rope, lower post-connection fixtures over side. Pull up into position using ropes placed through the two openings between the three panels. Note that bearing plate on top of post-connection fixture must be placed under center panel.

2 Remove cable retainer from vertical post by removing four 1/2-inch (1.3 centimeters) diameter bolts and hex nuts. Install vertical post using a rope over outside of bridge. Attach two ropes to the top of vertical post and pull it into position with ropes through the two openings between the three panels. Note that fixtures on vertical post for transverse braces must be on inside.

3 Attach brace-connection fixtures in a similar manner. Note that bolts on the brace-connection fixture not using the slotted holes in the bridge panel should not be tightened yet, to allow for lateral movement when fitting longitudinal brace.

4 Attach longitudinal and transverse braces, using a boatswain's chair.

WARNING: All personnel who are lowered over the side of the bridge in a boatswain's chair must also wear a safety belt connected to lashings, which, in turn, are secured to the side of the bridge.

Span junction posts

To install span junction posts and cable-connection beams, jack up end of bridge enough to place cribbing under lower panel chords near end posts to temporarily support bridge. Remove jacks from end of bridge.

Note: Ignore any reference to rocking rollers, since these items have been previously removed from under bridge.

Remove standard end posts from bridge and install span junction posts. Install cable-connection beams.

Cable assemblies

To install cable assemblies, do the preliminary procedure to prepare cables for installation on the bridge. Carry the cable across the bridge and install button end of cable through cable-connection beam on far shore. Then complete installation of cables as described earlier.

CABLE TENSIONING

Before tensioning the cables, set up a level reference so the deflection of a point on the bridge at midspan, relative to a point at the support, can be measured. The purpose of measuring deflections is to provide a check during cable tensioning. Tension all cables simultaneously.

Note: One 10-kilowatt or two 5-kilowatt, 60-cycle alternating current (ac) generators are required for operation of the hydraulic power unit.

To tension each cable, install an adapter and a double-acting hydraulic cylinder on each pull-rod assembly; connect the hydraulic hose to the cylinders and the hydraulic power unit; and install and tighten cylinder nut on each pull rod to retain adapter and cylinder of cable-tensioning assembly (Figure 15-20).

The hydraulic power unit is operated as follows:

1 Loosen filler plug to vent reservoir.

2 Place control-valve lever in advance position (inset, Figure 15-36).

3 Turn switch to RUN position.

4 Turn switch to OFF position when any cylinder has reached full stroke. The JOG position on switch may be used to run power unit in short bursts.

5 Pressure may be slowly released by moving control-valve lever toward center position.

The cable-tension gage (Figure 15-36) is located on the hydraulic power unit of the cable-tensioning assembly and the hand-driven hydraulic ram pump. The gage is $3^{1}/_{2}$ inches (8.9 centimeters) in diameter and has l-ton (.9 metric ton) graduations on the dial throughout a 60-ton (54.6 metric tons) scale. Cable tensions for the various bridge spans are given in Table 15-1.

Note: Loads should be read while tensioning cables. Readings during detensioning are inaccurate due to gage lag.

The retract position is used to return cylinders to normal operating position, after cable nuts have been tightened during tensioning procedures.

Operate the hydraulic power unit of the cable-tensioning assembly to cause one complete stroke of the cylinder at a time to tension the cables. Cable tensioning is accomplished in increments of cylinder strokes, as follows:

1 As cylinder advances, tighten cable nut by hand against bearing surface of the cable-connection beam. At the end of each cylinder stroke, release pressure, retract cylinder, and hand tighten cylinder nut back to retracted cylinder.

Note: If cable nut cannot be hand tightened because thread on pull rod is damaged or burred, use a Bailey structural wrench, as shown in Figure 15-37 (page 186) to pry

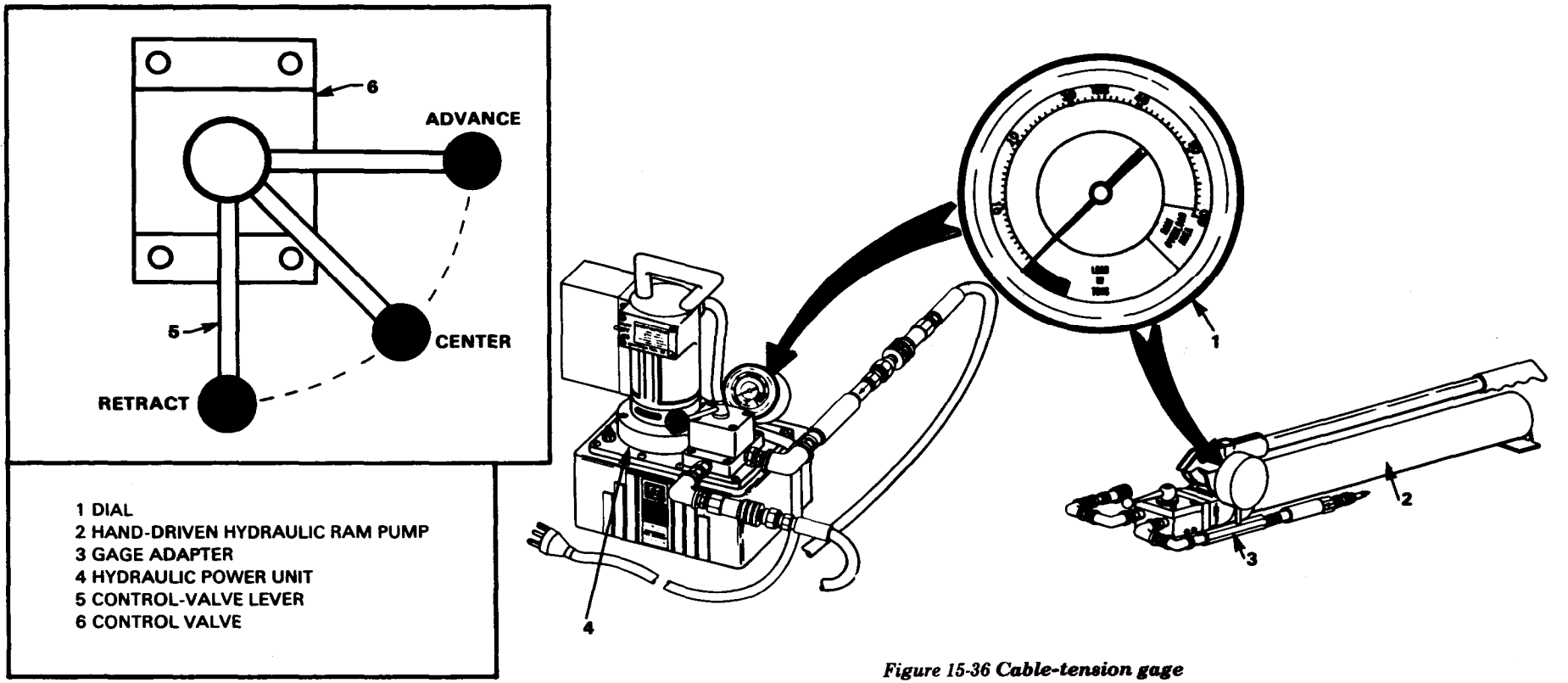


Figure 15-36 Cable-tension gage

cable nut free of damaged area. Hand tightening of cable nut can then be continued. Cylinder nut can also be turned through damaged or burred threads, using a chord-bolt wrench.

2 Repeat the last two steps until load, as indicated on gage of cable-tensioning assembly (Figure 15-38, page 186), is equal to 2 tons (1.82 metric tons) more than value listed in Table 15-1. Then slowly release pressure in hydraulic cylinder by slightly opening valve on hydraulic power unit until gage indicates a tension value 4 tons (3.64 metric tons) less than that listed in Table 15-1. Repressurize to appropriate value in Table 15-1. This must be done with the cylinders near midstroke.

Note: This procedure eliminates friction between the cable and vertical post.

3 Tighten cable nut against bearing surface of cable-connection beam. Release all pressure in cable-tensioning assembly by opening valve on power unit. Then hand tighten cylinder nut against cylinder.

Note: Cylinders must be fully retracted before disconnecting hydraulic power unit.

4 Measure deflection of bridge at midspan, relative to end of bridge. Compare the measured value obtained to values shown in Table 15-1. If the deflection measurement is less than the values listed in Table 15-1, refer to maintenance procedures later in this chapter for troubleshooting tips to correct conditions. As part of regular maintenance, check cable tension using manual hydraulic-pump assembly by pressurizing cylinders just enough to free cable nuts, and comparing gage reading with cable-tension value in Table 15-1.

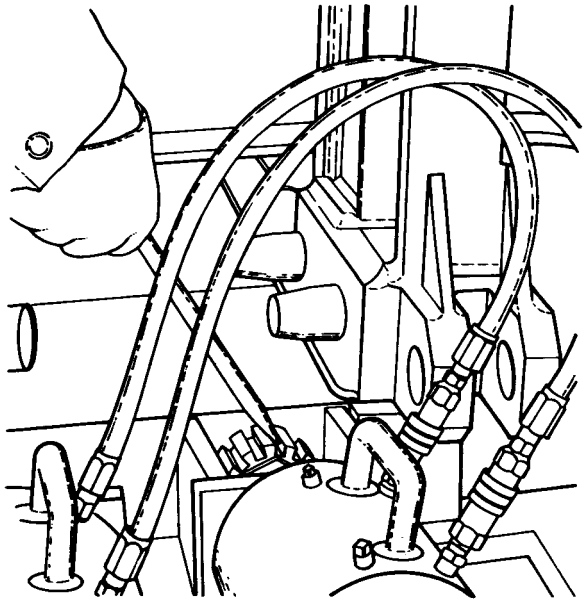


Figure 15-37 ***Using Bailey structural wrench to pry cable nut free of damaged area***

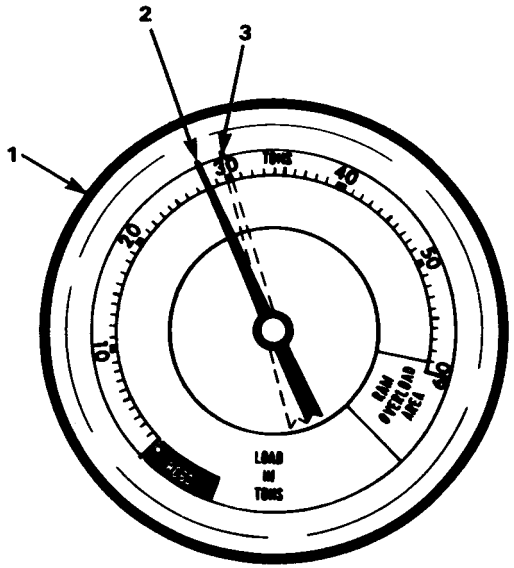


Figure 15-38 ***Typical load adjustment to eliminate cable friction as shown on cable-tension gage***

1 DIAL-INDICATING CABLE-TENSION GAGE OF CABLE- TENSIONING ASSEMBLY AND MANUAL HYDRAULIC- PUMP ASSEMBLY
2 28-TON LOAD REQUIRED FOR PROPER CABLE TENSIONING OF 40-FOOT PANEL BRIDGE M-2
3 2-TON CABLE-TENSION OVERLOAD

DISMANTLING OF SET

The sequence for dismantling the cable reinforcement set must be closely followed in order to prevent damage to equipment or possible injury to personnel.

Cable tension

To relieve cable tension, unload tension on all cables simultaneously, as follows:

1 Move cylinder nuts away from cylinders to 1/4 inch (.6 centimeter) lees than full cylinder stroke. By pumping, increase load on each cable until cable nut turns freely.

2 Keep cable nut free of cable-connection beam bearing surface while carefully opening valve on the power unit, permitting cylinder to slowly collapse.

3 Tighten cable nut against bearing surface when cylinder is almost completely collapsed. Cylinder should not be completely collapsed because tension in cable prevents hand loosening of cylinder nut.

4 Repeat the three steps above until tension in cables is relieved and cables are free of vertical-post saddles.

5 With cable nut against bearing surface of cable-connection beam, remove cylinder nut, cylinder, and adapter from pull rod.

Cable removal

To retrieve the cable, the following procedure for cable removal must be used for all cables installed on the M2 panel bridge

1 Reinstall lashing ropes 20 feet (6.2 meters) apart, along entire length of the cables. Make certain that cables are fully supported by lashings before continuing with removal operations.

2 Remove cable retainer from each vertical-post saddle by removing bolts and hex nuts.

3 On near-shore tensioning end of the bridge, continue retrieval as follows: unscrew cable nut from pull rod; pull pull rod out of cable-connection rod; remove bolt and hex nut which retain pull rod on rod-to-cable coupling, unthread pull rod from rod-to-cable coupling; and reinstall cable and cylinder nuts on threads of pull rod.

4 On the far shore, pull cable from dead-end cable-connection beam far enough to remove half-cable retainers. Then pull cable back through dead-end cable-connection beam.

5 Lift cable up and over panels of bridge. Carry cable to cable reel. Wind cable on cable reel, removing lashing ropes as cable wraps on reel.

Caution: **During winding of cable on cable reel, be careful to prevent cable buttons from snagging on structure, and cable from wearing against anything which could fray or break the wire.**

Cable-connection beams and span junction posts

To remove cable-connection beams and span junction posts correctly, do as follows:

1 Remove retainer clips from ends of panel pins (Figure 15-33).

2 Place safety cribbing under lower panel chords.

3 Install jacking lugs and railroad jacks, and jack up end of bridge enough to unload panel pins connecting span junction posts to connection beams.

4 Continue jacking up end of bridge until cable-connection beam is clear of span junction posts.

5 Install rocking rollers as when dismantling normal Bailey bridge (Chapter 21).

6 Jack bridge down onto rocking rollers.

7 Remove jacks, jack shoes, jacking lugs, span junction posts, and cable-connection beams.

Posts and bracing

To remove braces, post assemblies, and connection fixtures do the reverse of installation procedures outlined earlier in this chapter. After removing post assemblies from bridge, reinstall cable retainer on vertical-post saddle with four 1/2-inch (1.3 centimeters) diameter bolts and hex nuts. To complete dismantling, continue removal of the bridge as outlined in Chapter 21.

OPERATION UNDER UNUSUAL CONDITIONS

TEMPERATURE EXTREMES

The cable-reinforcement set can be installed and used in all extremes of temperature without a change of existing components. Cable tensions in Table 15-1 are higher than required under normal conditions, to compensate for extremes of temperature.

SPECIAL ENVIRONMENTS

When operating in dusty, sandy, tropical, or salty areas, do as follows:

- Lubricate cable, bridge set rockers, threaded surfaces, and slots in vertical-post saddles.
- Paint surfaces of parts which are subject to rust and corrosion, in accordance with TM 43-0139, if surfaces indicate absence of paint or excessive weathering. Do not paint cable.

OPERATOR'S AND ORGANIZATIONAL MAINTENANCE

BASIC TOOLS

Tools and equipment normally issued to the panel bridge company and those issued with the cable reinforcement set are adequate for maintaining this set. All maintenance will be performed by the using organization. Basic issue tools and supplies issued with or authorized for the cable reinforcement set are listed in Table B-1, and shown in Figure B-1, Appendix B. There are no special tools required to perform operator's and organizational maintenance on the cable reinforce ment set.

LUBRICATION

Lubrication of parts and equipment is an essential part of maintenance. Lubrication procedures are as follows:

- Keep all lubricants in closed containers and store in a clean dry place away from external heat. Allow no dust, dirt, water, or other foreign material of any kind to mix with lubricants. Keep all lubrication equipment clean and ready to use.
- Service lubrication points at proper intervals.
- Keep all external parts not requiring lubrication clean of lubricants.
- Before lubricating equipment, wipe all lubrication points free of dirt and grease.
- Clean all lubrication points after lubricating to prevent accumulation of foreign matter.

PREVENTIVE MAINTENANCE

To ensure that the cable reinforcement set is ready for operation at all times, inspect it systematically to discover and correct defects before they cause serious damage or failure. Note defects found during operation of the unit and correct them immediately. Stop operation at once if a defect is noted which would damage the equipment were operation continued. Every organization equipped with the cable reinforcement set must train its personnel to effectively maintain it.

Preventive maintenance checks and services are listed and described in Table B-3, Appendix B. The item list indicates the sequence of minimum inspection requirements.

MAINTENANCE PROCEDURES

Perform maintenance procedures as follows:

- Service the cable-tensioning and manual hydraulic-pump assemblies by checking the level of the hydraulic oil in the reservoir of the pumping unit and filling or draining this component. This includes replacing the gage, quick-disconnect couplings, or hose assemblies when inspection reveals a need for this.

Note: Always use the following standard procedures when disassembling a hydraulic component

1. Make certain all pressure has been relieved before opening any part of a hydraulic component.
2. Provide a container to catch any draining fluid.
3. Cover any exposed openings to prevent foreign matter from entering the hydraulic system.
4. Apply a small amount of pipe dope to all threaded connections to assure a tight connection.

WARNING: Do not permit open flames in immediate area because hydraulic fluid is flammable.

- Service the pumping reservoirs as shown in Figures B-2 and B-3, Appendix B.
- When inspection reveals the need, replace the following parts of the cable-tensioning assembly and manual hydraulic-pump assembly, as illustrated and described in Figures B-4 and B-5, Appendix B, respectively: cable-tension gage; hose assemblies and quick-disconnect couplings; gage adapter (hand pump only); and cylinders (cable-tensioning assembly only).

TROUBLESHOOTING

Malfunctions which may occur in the cable reinforcement set and its components are listed in Table B-4, Appendix B. Each malfunction is followed by a list of probable causes of the trouble and the corrective action recommended to remedy it. Malfunction may occur while the cable reinforcement set is being used in the field where supplies and repair parts are not available and normal corrective action cannot be done. When this occurs, follow the expedient remedies also listed in Table B-4, Appendix B.

REPAIR PARTS

Repair parts needed to maintain the cable reinforcement set are listed in Table B-5, Appendix B. A number of these parts are illustrated in Figures B-6 through B-12, Appendix B.

SHIPMENT AND LIMITED STORAGE

PREPARING FOR SHIPMENT

Prepare the cable reinforcement set for domestic shipment as follows

1 Inspect entire unit for unusual conditions such as damage, rusting, and theft. Do preventive maintenance services outlined earlier in this chapter.

2 Remove all contamination from unit by an approved method. Approved methods of cleaning and drying, types of preservatives, and methods of application are described in TM 38-230-1.

3 Repaint all surfaces where paint has been removed or damaged. DO NOT paint the cables.

4 Complete properly annotated DA Form 2258 (Depreservation Guide for Vehicles and Equipment), concurrently with preservation for each item of mechanical equipment, and outline unusual needs in blank space on form. Put completed guide in waterproof envelope marked "Depre servation Guide," and fasten it in a conspicuous place. Before using equipment, and before inspection, do depreservation of the item as outlined in the guide.

5 Coat exposed machined surfaces with preservative (P-6), conforming to specification MIL-C-11796, class 3. If preservatives is not available, GGP-GREASE, General Purpose, may be used.

LOADING EQUIPMENT

To load the equipment for shipping, use a lifting device of suitable capacity to lift heavy components. The cable reinforcement set may be transported in three M51 trucks. One truck transports cables, reels, and supports, another transports the span junction post, and the third truck transports the remaining parts of the cable reinforcement set (Figures 15-5, 15-6, and 15-7).

Caution: **Attach a guide rope when lifting the equipment to avoid swinging and damaging the cable reinforcemnent set.**

Securely block and lash the cable reinforcement set in M51 trucks. The cable-tensioning assembly is contained in its own box with protective wrapping. Also, the pull rods can be stored in cardboard tubes to protect the threads from dirt or other foreign matter. This set may also be stored in a shelter or motor pool. If stored in the open, make sure components are placed on cribbing to reduce rust and corrosion.

CHAPTER 16
BRIDGES ON PIERS

BROKEN-SPAN BRIDGES 190
CONTINUOUS-SPAN BRIDGES 198
CANTILEVER-SPAN BRIDGES 206

Long simple spans become increasingly uneconomical because of excessive dead weight and reduced class. Generally, intermediate piers should be used to avoid assembly of class 50 continuous spans longer than 150 feet (46.2 meters) or class 75 continuous spans longer than 120 feet (36.9 meters). Bridges supported by piers may be either broken (at each pier) into separate spans or continuous for their entire length. For efficient assembly, the time required to assemble one span and prepare it for launching should be as nearly equal as possible to the time required to assemble and place one pier.

BROKEN-SPAN BRIDGES

DESCRIPTION

Broken-span bridges are multispan structures with the top chord broken and the bottom chord either broken or pinned at the piers. The two adjacent spans act independently under load. One advantage of broken-span over continuous-span assembly is that the reaction on intermediate piers is less. Also, pier settlement will not result in reduced bridge capacity, adjacent spans may be of any length, and seating operations are simplified. Existing piers of demolished structures (Figure 16-1), panel crib piers, framed bents or cribs (Figure 16-2), pile piers, or combinations of these (Figure 16-3, page 192) are used for intermediate supports.

ASSEMBLY

Independent spans can be single-, double-, or triple-truss and single- or double-story assembly. If truss assembly is changed over the pier when using conversion set No. 3 (Chapter 17), the heavier assembly should be continued for two bays into the lighter assembly to stabilize the junction link. For example, if a *double-single* bridge is joined to a *triple-single* or *double-double* bridge, the *triple-single* or *double-double* should be continued for two bays past the junction into the lighter truss types. Keep transom clamps in these bays tight. If a triple-truss panel crib pier supports a double-truss bridge, distribute the load to all trusses in the pier by triple-truss assembly, and use three transoms over the pier and in three adjacent bays of each span.

Piers

Any type of supporting crib or pier capable of

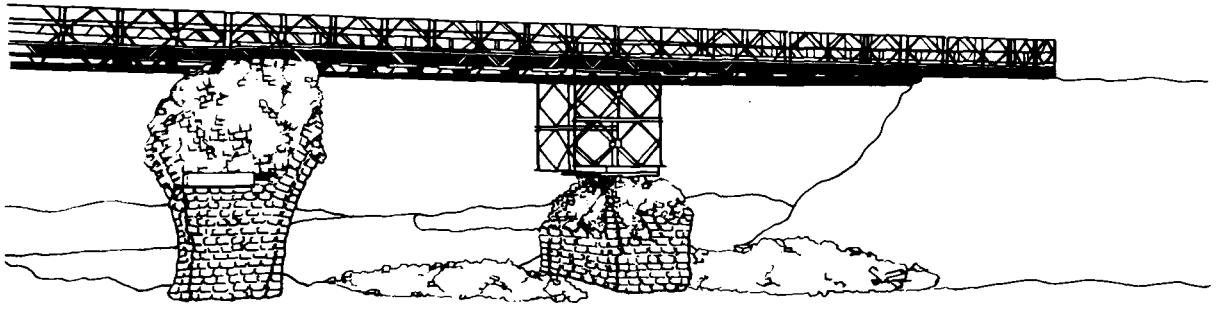


Figure 16-1 ***Continuous-panel bridge supported on damaged masonry pier and a panel crib pier***

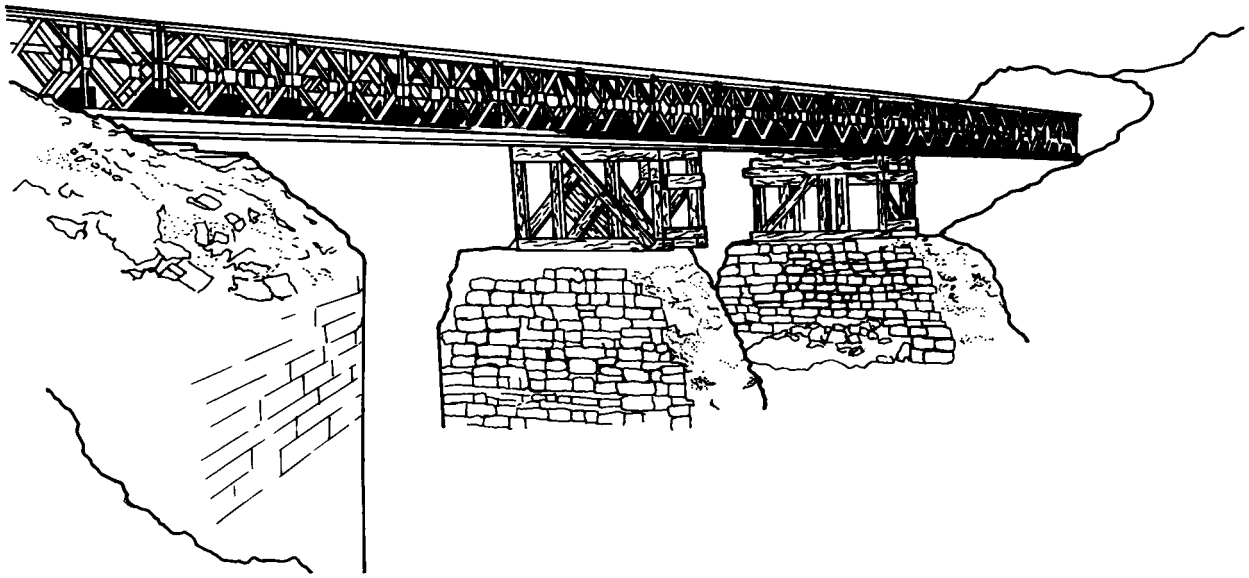


Figure 16-2 ***A 170-foot (52.3 meters) DS continuous-panel bridge supported on timber piers***

taking the end reactions of the spans can be used. Bailey-type panel crib piers for supporting broken-span bridges are described in Chapter 17. It is desirable to make the top of all piers in the same plane as the abutments, but a change in slope between spans may be used if needed. Guy tall, narrow piers to prevent lateral movement.

Bridge seatings

With panel crib pier parts (conversion set No. 3), take special care that piers are exactly aligned and spaced so that the ends of two adjacent spans are on a common junction-link bearing. Attach span junction posts to the end of each span, and pin the posts to the junction links fitting in junction-link bearings. Bridge gap between two spans with junction chess. The use of standard conversion set No. 3 severely limits the bridge pier reaction.

If the panel crib pier parts are unavailable, attach the end posts to the ends of adjacent spans and seat on separate bearings (Figure 16-4, page 192). Use any of the following three methods to bridge the gap between spans:

- If junction chess are used, seat an extra transom in the end posts of one span and space the bearings 21¾ inches (55.4 centimeters) apart center to center (Figure 16-4).
- If junction chess are unavailable, use seventeen 4- by 4-inch (10.2 by 10.2 centimeters) timber stringers decked with two chess. If bearings are butted against each other (Figure 16-5, page 192), the stringers must be 2 feet (61.1 centimeters) long.
- Standard stringers cut to desired length can be used to bridge the gap between spans.
- If bearings are spaced 4 feet 6 7/8 inches (1.4 meters) center to center, bridge the gap by setting standard panel-bridge stringers back 5 feet (1.5 meters) along bridge (Figure 16-6, page 192). Use extra panels to support overhanging stringers at one end of bridge.

If end posts are not used, fasten steel plates to pier cap for truss bearings. Pin only the lower chords of spans. Omit top pin at junction so two spans can act independently.

If timber trestle or pile bents are used as intermediate piers, build the top of the bent as shown in Figures 16-7 through 16-11 (page 193). If end posts are not used, reinforce the capsill with a steel bearing plate under each line of trusses. On single bents, use corbels with knee braces to provide a jacking platform for light bridges (Figure 16-8). If double bents are used with end posts and standard bearings, lay timbers across caps to provide a platform for seating bearings (Figures 16-10 and 16-11). Group timbers together under each line of trusses.

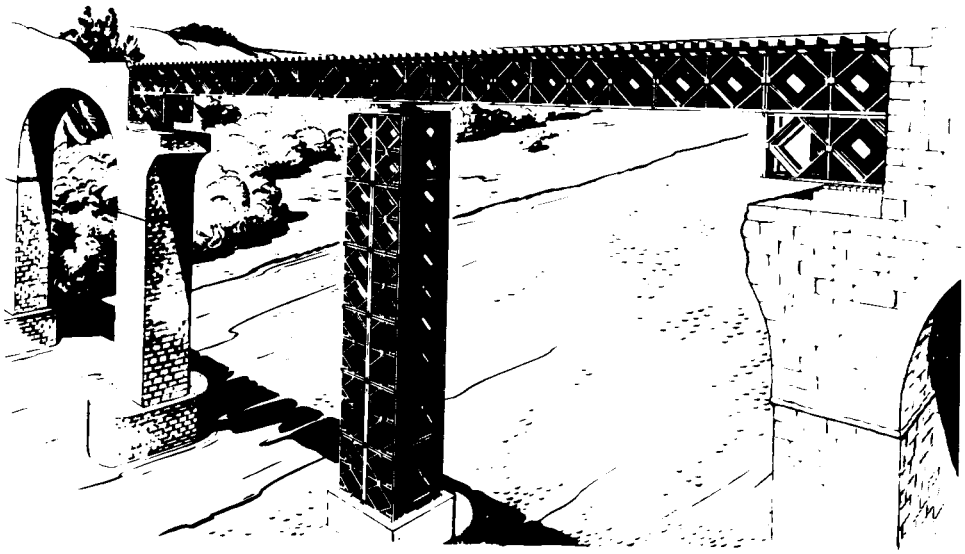
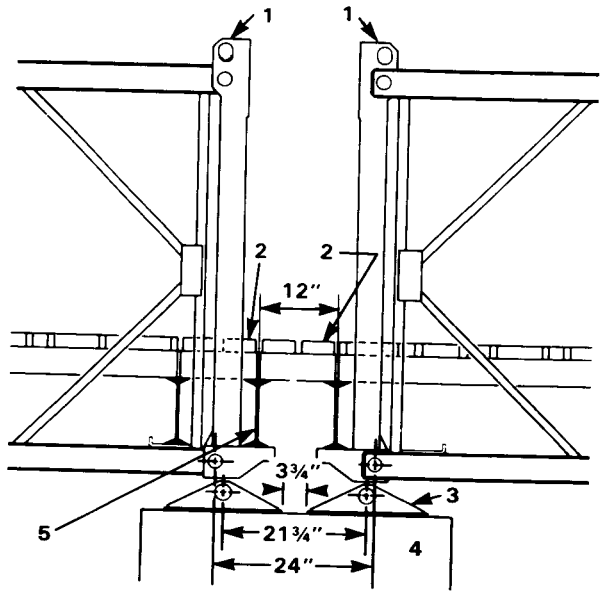
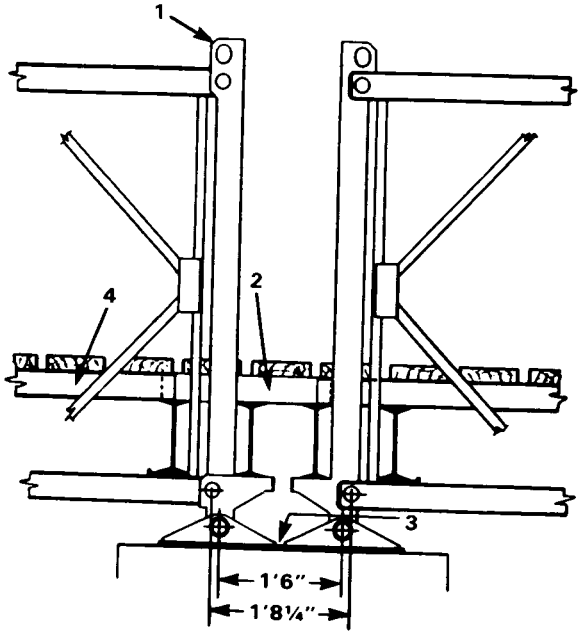


Figure 16-3 ***Panel bridges supported on various types of piers***



1 END POSTS
2 JUNCTION CHESS
3 BEARING
4 PIER
5 EXTRA TRANSOM

Figure 16-4 ***Bearings on pier at adjacent ends of two intermediate spans***



1 END POST
2 TIMBER STRINGER
3 BEARINGS BUTTED TOGETHER
4 STANDARD STRINGER

Figure 16-5 ***Use of 4- by 4-inch (10.2 by 10.2 centimeters) stringers 2 feet (61.1 centimeters) long to fill gap between end of spans***

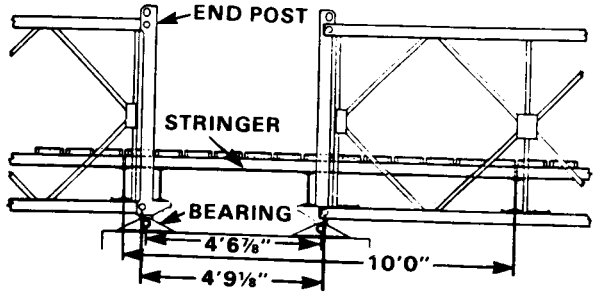


Figure 16-6 ***Two spans supported on a common pier***

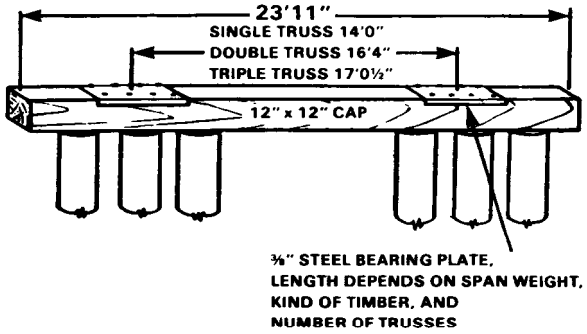


Figure 16-7 ***Construction of pile caps for intermediate supports under panel bridges without end posts or bearings****—cap for single timber or pile bent; steel bearing plates for seating each line of trusses*

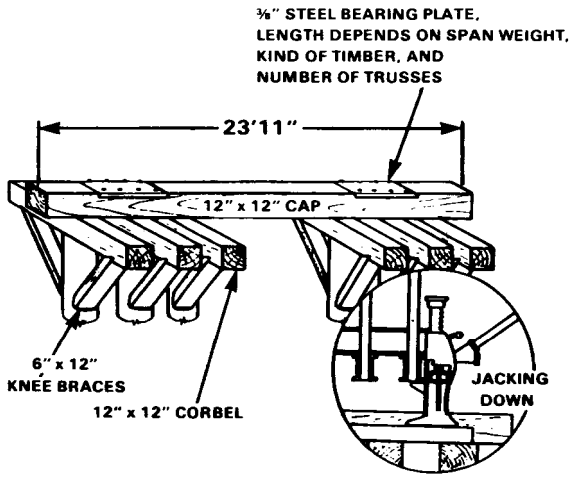


Figure 16-8 ***Construction of pile caps for intermediate supports under panel bridges without end posts or bearings****—corbels and knee bracing added to provide a jacking platform*

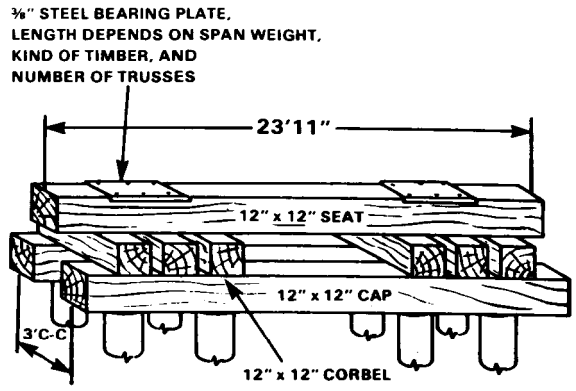


Figure 16-9 ***Construction of pile caps for intermediate supports under panel bridges without end posts or bearings****—cap for double trestle or pile bent*

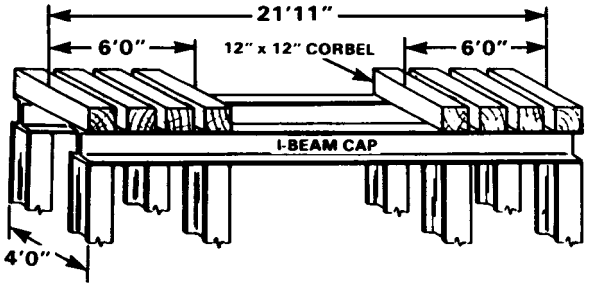


Figure 16-10 ***Construction of pile caps to provide seating for bearings at adjacent ends of independent spans****—steel piles and caps*

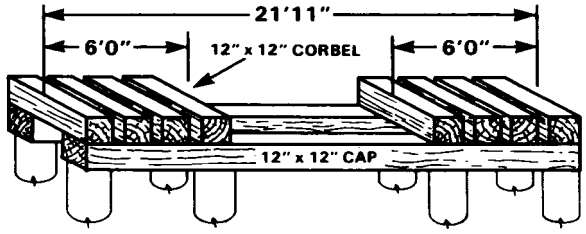


Figure 16-11 ***Construction of pile caps to provide seating for bearings at adjacent ends of independent spans****—wood piles or trestle and cap*

CLASS

Normal spans, spans without end posts, and piers each have their own class designation, as follows:

- Since spans of a broken-span bridge act independently, each span has the same class when fitted with end posts or span junction posts as a simple-span bridge of the same span length and type of assembly.
- If end posts or span junction posts are not used, the class of spans is limited. For classes of Bailey bridges without end posts, see Table 22-3.
- In a series of broken spans, the class of the weakest span is the class of the bridge. For classes of panel crib piers, see Chapter 17.

The load on a pier from two adjacent independently supported spans can be computed. The formula is based on a vehicle spacing of 100 feet (30.8 meters). Allowing 15 percent of the live load for impact, and a coefficient of 1.13 for eccentricity, the total factor is 1.3. The formula is—

$R = 1.3P + {}^{1}/_{2} W_d$

R = load in tons on pier.

P = maximum live-load shear in tons.

W_d = total dead weight in tons of the two spans.

The following example illustrates how to find the pier reaction of a broken-span bridge:

Given:

Spans of 130 and 80 feet (40 and 24.6 meters) on each side of an intermediate pier.

Broken-span panel bridge to span these gaps must carry class 50 load in normal crossing.

Required:

Determine bridge assembly needed.

Determine load on pier.

Solution:

From Table A-7, Appendix A, the 130-foot (40 meters) span will require *triple-double truss* assembly and the 80-foot (24.6 meters) span *double-single* truss assembly. The *triple-double* construction must be continued for two bays of the *double-single* construction to stabilize the junction link.

Using the formula given, P is determined from Figure 16-12 by entering the bottom of the graph at 210 feet (64.6 meters) (total of the two spans), reading up to the class 50 curve and then to the left margin. In this instance P is determined to be 74 tons. To determine W_d, refer to Table 1-2 which shows that *one* bay of *triple-double* bridge weighs 5.88 tons and one bay of *double-single* weighs 3.41 tons. The heavier construction must be continued two bays into the lighter construction. This results in 15 bays of *triple-double* and 6 bays of *double-single* construction. By multiplication we find W_d is 108.66 tons. Load on pier is then—

$R = 1.3P + {}^{1}/_{2} W_d$
$= 1.3(74) = {}^{1}/_{2}(108.66)$
$= 96.2 + 54.33$
$= 150.53$ tons

METHODS OF LAUNCHING

Broken-span bridges are launched by cantilevering the entire bridge with launching nose over the gap as a continuous bridge and breaking it, by launching each span by single girders, or by floating each span into position.

LAUNCHING AS A CONTINUOUS BRIDGE

Normally, an entire single- or double-story bridge with nose is launched over intermediate piers and then broken at the piers. Long, heavy single- or double-story bridges can be launched incomplete to make the launching easier. Connect the spans directly or by span junction posts and launching links. Push the bridge across the gap or pull it across by winch line. In general, launch a continuous bridge as follows:

1 Place rocking rollers on each pier and on abutments in the same horizontal plane. Spike or lash rocking-roller bearings, base plates, or templates to piers to prevent shifting during launching. When span junction posts are not used and the bridge is to be cut over the pier, the pier top must be wide enough to allow placing of two rocking rollers end to end under each truss.

Note: The number of rocking rollers on a pier must be equal to the number required on the near shore.

2 Use a launching nose in the same manner as for a normal bridge. The length of the launching nose should be the same as required for a single span bridge of the same length as the longest span in the broken-span bridge. Use launching-nose links in bottom chords of nose to compensate for sag. When estimating sag in nose to determine position of links, allow an extra 6 inches (15.3 centimeters) of sag for safety.

3 During launching, guy piers to offset longitudinal thrust of the bridge. When

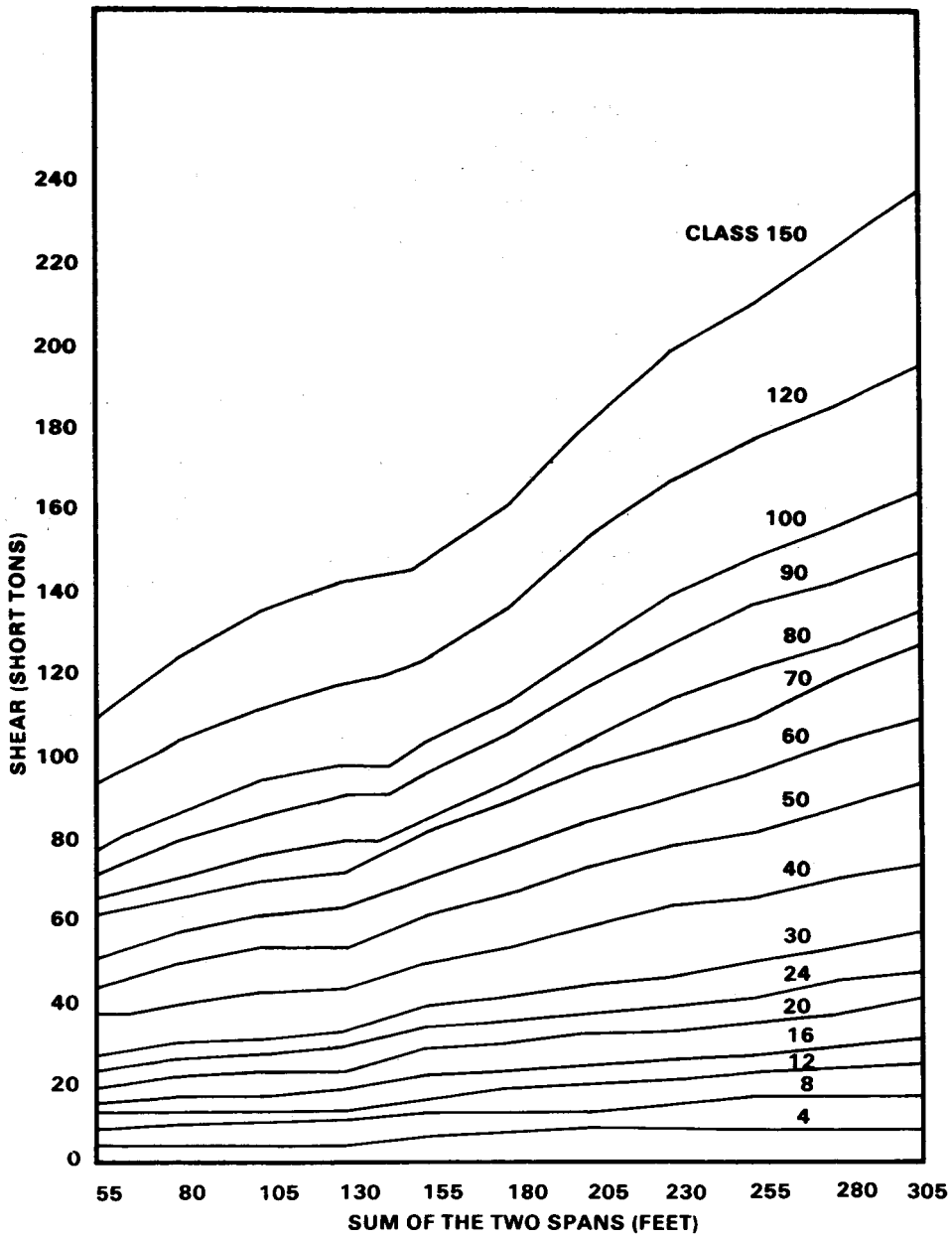


Figure 16-12 ***Standard class curves***

completely launched, pull bridge back slightly to relieve stress in guy lines.

4 Jacking down over intermediate piers requires jacking beams similar to those described later in this chapter.

SPANS WITH SPAN JUNCTION POSTS ON JUNCTION-LINK BEARINGS

Launch spans with span junction posts on junction-link bearings as follows:

1 Fit span junction posts to ends of spans and pin bottom jaws of adjacent posts together. Three methods of making junctions are-

- If spans are all the same length, begin with first junction and fit alternate junctions with launching links between tops of span junction posts. This makes bridge continuous at these points. These junctions are called locked junctions. Do not connect top chords at other junctions.

- If spans are not all the same length, make first length of continuous bridge plus launching nose twice the length of longest span. This counterweights the nose over the gap.

- In double-story assembly, place span junction posts in each story. Pin the bottom jaws of posts in lower story together and use Mk II launching-nose links to connect top of posts in top story. Do not make a pin connection

between posts at top of lower story and bottom of top story.

2 Remove launching-nose links from top chords at locked junctions by the following two methods:

- For bridges with several long heavy spans, remove launching-nose links at point of contraflexure. In a continuous girder, there is a point near each support where the girder changes from a downward sag in the gap to an upward bend over the pier. At this point (point of contraflexure), there is no bending moment in girder, no stress in links in top chord, and panel pins are easy to remove. If the pins are heavily greased, they can be pulled by hand. To find point of contraflexure in span, station personnel at each link to test pins for slackness as soon as links are one-third span length from far pier. Push bridge ahead slowly and continue to test pins. When pins are loose, remove links. After removing links, continue launching until bridge is in final position over piers. Then jack down bridge simultaneously at alternate supports.

- For short light bridges of two or three spans, remove launching-nose links over piers. Launch bridge completely before attempting to remove links. After launching, jack up ends of bridge and substitute cribbing at same height as rocking rollers at abutments. Then remove rollers and cribbing at each center pier and jack bridge down slowly. As jacks at center pier are lowered, tension in top chord decreases. When tension is zero, remove pins in Mk II links. Then jack bridge down on center pier. Repeat this procedure at adjacent piers, working toward abutments. See Table 16-1 for maximum lengths of bridge and jacking arrangements, based on dead weight of two spans over the intermediate pier. When using this table, note the following:

  - For heavier bridges, use jacks at the pier also.

  - With jacks arranged as in Figure 16-18 (page 205), and two jacks under trusses at each side of bridge, jack strength (15 tons) limits this arrangement to a capacity of 56 tons. With four jacks used instead of two under trusses, jack strength limits this arrangement to a capacity of 111 tons.

  - With jacks arranged as in Figure 16-19 (page 205), and 6 jacks under trusses at each side of bridge, jack strength limits this arrangement to a capacity of 85 tons (jack strength on toe is 7.5 tons). With 12 jacks used instead of 6 under trusses, jack strength limits this arrangement to a capacity of 168 tons, and two ramps on each side of bridge are needed.

  - Whether 2, 4, 6, or 12 jacks are used, truss spacing causes eccentric load on jacking beam.

SPANS WITH END JUNCTION POSTS ON STANDARD BEARINGS

Launch spans with end posts on standard bearings as follows:

1 Launch as a continuous bridge until far span is in position.

2 Disconnect far span from rest of bridge, and pull bridge back until next span is in position. To remove pins, bridge may be jacked up slightly either at junction or at end.

3 Repeat procedure until all spans are disconnected over their piers.

4 Pin end posts to ends of spans, and jack spans down on bearings.

LAUNCHING WITHOUT END POSTS

Launch spans without end posts as follows:

- If bottom chords of all spans are to be pinned together and only top chords broken at piers, make junctions, launch bridge, and remove pins in same manner as for spans with span junction posts.

- If both top and bottom chords are to be broken at piers, launch bridge in same manner as for bridge with end posts.

Table 16-1 ***Maximum lengths of two adjacent spans of a continuous bridge that can be jacked over intermediate pier***

TYPE OF CONSTRUCTION			SS		DS		TS		DD		TD		DT		TT	
			SHORT	LONG	SHORT	LONG	SHORT	LONG	SHORT	LONG	SHORT	LONG	SHORT	LONG	SHORT	LONG
JACKS ARRANGED AS IN FIGURE 16-18	JACKS UNDER TRUSSES AT EACH SIDE OF BRIDGE	TWO	0-35 40 45-55	60 55	0-55 60-70 75-90	95 90	0-65 70-80 85-95 100-105	115 110 105	0-50 55-70 75-80	85 80	0-40 45-55 60-65	70 65	0-35 40-50 55-65	65 60	0-30 35-45 47.5	50 47.5
		FOUR	0-55 60-100	100	0-80 85-140	140	0-95 100-160	160	0-105 110-180	180	0-95 100 105-120 125-135 140-145	160 155 150 145	0-75 80-100 105-115 120	130 125 120	0-60 65-75 80-90 95	105 100 95
JACKS ARRANGED AS IN FIGURE 16-19		SIX	0-55 60-100	100	0-80 85-140	140	0-95 100-160	160	0-85 90-110 115-125 130-140	150 145 140	0-65 70 75-85 90-100	110 105 100	0-55 60-65 70-80 85-90	100 95 90	0-45 50-55 60-70 72.5	80 75 72.5
		TWELVE	0-55 60-100	100	0-80 85-140	140	0-95 100-160	160	0-105 110-180	180	0-115 120-200	200	0-125 130-185 190-195 200	210 205 200	0-95 100-110 115-125 130-140 145	160 155 150 145

LAUNCHING BY SINGLE GIRDERS

To launch by single girders, assemble bridge by launching girders of each span from deck of previously completed spans. Add transoms and decking after girders are in place. For detailed procedure, see Chapter 19.

LAUNCHING BY FLOTATION

To launch by flotation, assemble span on rollers on shore, launch onto pontons or crafts, and float into position between piers. For detailed procedure, see Chapter 18.

JACKING ON PIERS

Where it is necessary to jack on intermediate piers, the distance through which the bridge is raised or lowered should be kept to the minimum by adjusting the levels of the intermediate rollers. In the case of flat cribs, the jacking problem is considerably eased, since the jacks can be readily positioned under the inner trusses of the bridge. A satisfactory method of jacking the bridge off the intermediate rollers and positioning the distributing beams is as follows:

1 Place jacks beneath panel verticals or diagonals of inner trusses on each side of bridge with handles toward the center, and remove sway braces. Lift bridge clear of rocking rollers, and remove rollers and cribbing. Place temporary cribbing under inner trusses, and position base plate with bridge bearing placed centrally.

2 Place distributing beams on bridge bearings under middle and outer trusses. Jack down to within 3 inches (7.6 centimeters) of final position. Place cribbing

between bottom chords of bridge and top of distributing beams and lower bridge on the cribbing. Remove jacks from under inner truss.

3 Put distributing beams centrally under inner truss so that crib bearing is over bridge bearing.

4 Place jacks beneath distributing beam under inner truss of bridge, jack up, remove packing from middle and outer trusses, and lower onto bearings.

5 Weld guide plates to end stiffeners of distributing beams, with lug on top of plate between middle and inner trusses.

6 Secure bridge bearing in position in base plate with timber.

MAINTENANCE

Check periodically to record any sinking of piers. Prevent lateral shifting of the bridge by timber blocking on each side of bearings and lateral guy lines on high piers.

CONTINUOUS-SPAN BRIDGES

ADVANTAGES

A continuous-span bridge is one in which both upper and lower chords are continuous over intermediate piers between abutments. Advantages of continuous-span bridges are that siting of piers is not limited to 10-foot increments or to exact longitudinal alignment by panel junction, as in broken-span bridges. Assembly is faster and class is increased for most types of assembly. Classes for continuous spans over piers are found in Table 16-2.

ASSEMBLY

The number of spans is limited by the effect of harmonious vibration setup by loads and by the difficulty of keeping long bridges in alignment during launching. Normally, continuous-span bridges are limited to four spans or 500 feet (153.8 meters).

The maximum span of a continuous-span bridge to carry a specified load is given in Tables 16-2 and 16-3. The short span must be at least 60 percent of the length of the longer adjacent span. If the short span is less than 60 percent, a heavy load on the long span

*Table 16-2 **Classes for** equal **spans of continuous-panel bridge, Bailey type M2***

SPAN (ft)	SS CLASS	DS CLASS		TS CLASS		DD CLASS		TD CLASS		DT CLASS		TT CLASS	
	W	W	T	W	T	W	T	W	T	W	T	W	T
30	24												
40	20												
50	20	65*	65										
60	20	60	60										
70	16	50	55										
80	16	45	50	80	80								
90	12	40	45	70	70								
100	12	35	40	60	60	90	90*						
110		30	35	50	55	80	80	100*	90*				
120		20		40	45	65	70	90	90*				
130		16		30	35	50	55	80	80	90	90*		
140		12		24		40	45	60	65	75	80		
150				20		30	35	50	55	65	75		
160				16		24		40	45	60	65	80	90*
170						16		30	35	50	60	75	85
180						12		20		40	45	65	75
190								16		30	30	50	55
200												35	40

*Limited by roadway width
Note:
W represents wheeled-load class
T represents tracked-load class

Table 16-3 ***Classes for unequal spans of continuous-panel bridge, Bailey type M2***

SPAN (ft)	SS CLASS W	DS CLASS W	DS CLASS T	TS CLASS W	TS CLASS T	DD CLASS W	DD CLASS T	TD CLASS W	TD CLASS T
50-30	20	70	70						
60-40	20	65	65						
70-40	16	55	60						
80-50	16	50	55	85	85				
90-60	12	45	50	75	75				
100-60	12	40	45	65	65	100*	90*		
110-70		35	40	55	60	85	85		
120-70		24		45	50	70	75	100*	90*
130-80		20		35	40	60	65	85	85
140-90				30	30	50	55	75	80
150-90				24		40	45	65	70
160-100						30	35	55	55
170-110						24		40	45
180-110								30	35
190-120								24	

*Limited by roadway width
Note:
W represents wheeled-load class
T represents tracked-load class

raises the end of the short span off its bearing. If spans less than 60 percent are essential, break the bridge at the pier to make the short span independent.

Change of assembly over a pier

Avoid changes in truss assembly whenever possible. If changes must be made, change number of stories rather than number of trusses to give better redistribution of stresses between adjacent spans. If one pier is used, the construction of both sides of the pier should be the same. Use Table 16-2 for equal-length spans and Table 16-3 for unequal-length spans. For both types of span, bridges with a normal rating over class 70 must be built with double transoms.

If two or more piers are used in the assembly of continuous spans (for example, 120 feet [36.9 meters], 120 feet, and 70 feet [21.5 meters]), the assembly may change over the last bay of the bridge. To determine whether a change is permissible, check Tables 16-2 and 16-3 to see if the lighter construction will give a sufficient class. Extend heavier assembly of longer span beyond intermediate pier a distance equal to 25 percent of shorter span. Make only the following changes of assembly between spans: *single-single* to *double-single, double-single* to *double-double, triple-single* to *triple-double,* and *double-double* to *double-triple.* Whenever *double-double* or *double-triple* truss types are used, they must be reinforced to *triple-double* and *triple-triple* respectively over a pier for two bays on each side of the pier-bridge connection.

Construction of piers

Use any type of supporting crib or pier capable of taking the reactions of the spans. Piers are normally built before the bridge is launched over them. Where piers are inaccessible from the ground because of extreme height or a rapid stream, a high line can be used in construction or the soldiers and materials can be lowered from the end of the cantilevered launching nose of the bridge. Figure 16-13 (page 200) illustrates how this has been done. On two-span bridges, the bridge may be launched across the gap and pier parts lowered from the bridge. Be sure to check the capacity of the bridge over the combined gap to ensure that it will carry the pier construction crew and materials. Guy tall, narrow piers to prevent lateral movement.

Construction of bridge seating

Some form of rocker bearing must be used at the intermediate pier to allow for deflection of girders under load. Normally, a rocker bearing for the bridge is placed at the top of the pier. If a rocker is placed at the base of the pier, the bridge can be fastened rigidly to the pier (Chapter 17). Various types of rockers at top of pier are described below. The distributing beam on the rocker bearing must be strong enough to prevent excessive local bending in the bottom panel chord. Table 16-4 (page 200) gives the number of panel-support points (points under panel verticals

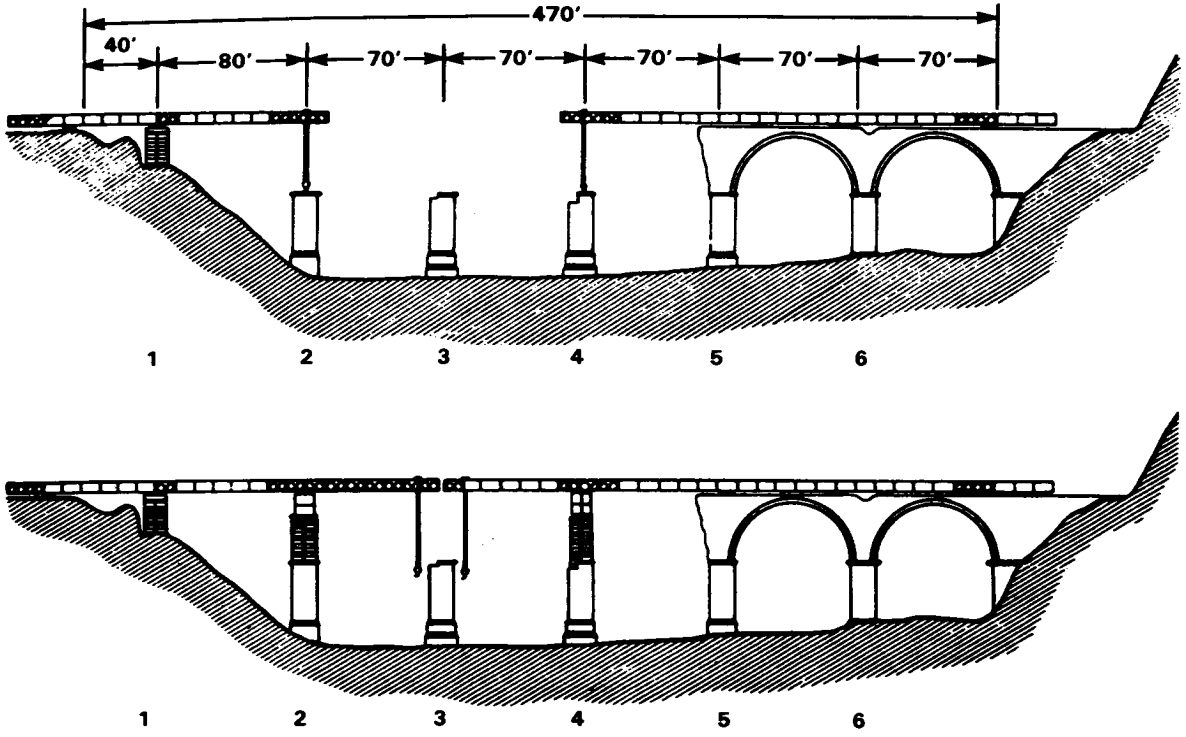


Figure 16-13 ***Piers 2, 3, and 4 constructed from ends of bridge cantilevered out from each bank***

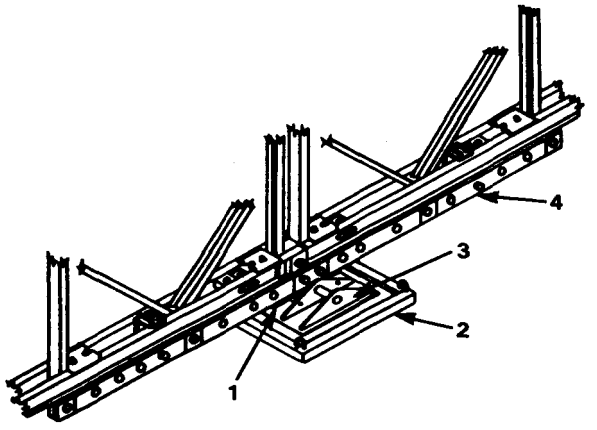
and junctions of panel diagonals) that must be effectively supported by the distributing beam to prevent excessive bending stress in the bottom chord. The procedures for providing rocker support to panel-support points are as follows:

- When rocker must support two panel-support points, use a crib capsill, crib bearing, and standard bearing from the panel crib pier set as shown in Figure 16-14. Because of the flexibility of the crib capsill, this rocker gives full support to only two panel-support points. Pier reaction with this arrangement is limited to 17 tons (15.5 metric tons) per truss.
- When rocker must support three panel-support points, use a crib capsill, an inverted junction-link bearing, and a junction link from the panel crib pier set as shown in Figure 16-15. Pier reaction with this arrangement is limited to 25 tons (22.3 metric tons) per truss.

Table 16-4 ***Pier reactions and panel-support points for continuous-panel bridge, Bailey type M2***

SPAN (ft)		TYPE OF CONSTRUCTION SS	DS	TS	DD	TD	DT	TT
30	A	46						
	B	2						
40	A	45						
	B	2						
50	A	47	115					
	B	2	3					
60	A	49	107					
	B	2	2					
70	A	52	106					
	B	2	2					
80	A	55	109	167				
	B	2	2	3				
90	A	61	117	172				
	B	3	3	3				
100	A	66	112	155	226			
	B	3	2	3	3			
110	A		107	148	205	279		
	B		2	2	3	3		
120	A		100	127	200	268		
	B		2	2	3	3		
130	A		99	128	194	268		
	B		2	2	3	3		
140	A		100	127	174	259	325	
	B		2	2	3	3	4	
150	A			121	174	248	309	
	B			2	3	3	4	
160	A			122	166	222	315	418
	B			2	3	3	4	4
170	A				161	209	318	413
	B				3	3	4	4
180	A				161	197	290	420
	B				3	3	4	4
190	A				152	190	276	383
	B				3	3	4	4
200	A							353
	B							4

Note:
A = Pier reactions (tons) at junction of two equal spans; reaction at junction of unequal spans is average of reactions tabulated for two equal spans of each span length
B = Number of panel-support points to be supported by rocker bearings



1 CRIB BEARING
2 BASEPLATE
3 STANDARD BEARING
4 CRIB CAPSILL

Figure 16-14 ***Rocker bearing to support*** *two* ***panel-support points*** *made from crib capsill, crib bearing, and standard bearing*

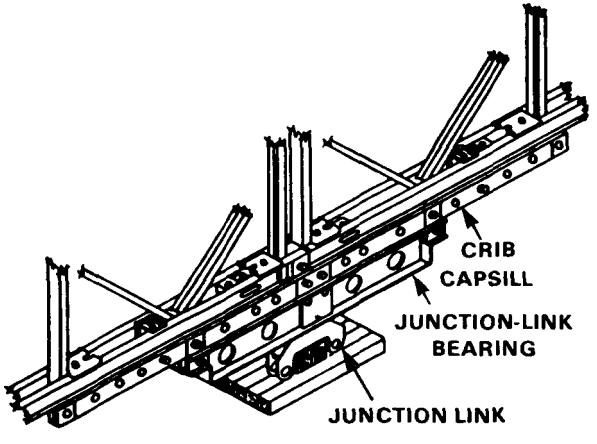


Figure 16-15 ***Rocker bearing to support*** *three* ***panel-support points*** *made from crib capsill, inverted junction-link bearing, and junction link*

- When rocker must support five panel-support points, reinforce the crib capsill in Figure 16-14 with an 8-foot 4-inch (2.6 meters) section of transom as shown in Figure 16-16 (page 202). Weld capsill, transom, and crib bearing together and pin by chord clamps to panel chord. Weld small channels across bottom of transom sections at each side of bridge to give lateral stability to each rocker. Weld more diaphrams and an end plate to the rocker bearing. The crib capsill may be omitted if a 10-foot (3.1 meters) section of transom is used, but end plates must be recessed to prevent lateral movement of the trusses being supported.

Anchoring of bridge

Allowance must be made for slight longitudinal movement of the bridge due to deflection under loads, and for expansion and contraction due to temperature changes. With temperature changes of 60 degrees Fahrenheit (15.6 degrees Centigrade), a movement of 1/2 inch (1.3 centimeters) per 100 feet (30.8 meters) of bridge can be expected. To allow for this movement, grease base plates so bearings can move longitudinally on them. Restrain the bearings laterally with timber guides. If sloping bridges are erected, alternate expansion and contraction makes the bridge creep downhill. To offset this, keep slopes under 1 in 30 and fix the uphill end of bridge to prevent creeping. At the end of a bridge with a short end span, lash or clamp end posts to bearings so posts cannot jump their seatings if end of bridge lifts when a heavy load is on the second span.

Leveling supports

The bottom chord of the bridge must be in the same plane over all the intermediate supports. Normally, this plane is level, but a slight inclination is permissible. If any pier settles more than 6 inches (15.3 centimeters) below the bridge plane, then the rockers must be cribbed up. Without the cribbing, the superstructure will fail.

PIER REACTION

The class of continuous-span bridges varies with span lengths. For shorter spans, it may be less than that of broken-span bridges because shear at the piers is greater. Tables 16-2 and 16-3 give the capacities of continuous-span bridges. Note that in most cases, the class is greater than it is for corresponding simple spans. Table 16-4 gives pier reactions and the number of panel points (points under panel verticals and junctions of panel diagonals) that must be supported by the rocker-bearing distributing beam to distribute stresses in bridge panels over the pier. The rocker bearing shown in Figure 16-16 has a distributing beam long and stiff enough to support five panel-support points and suitable for any of the spans in the tables.

The following example illustrates how to use this table:

Given:

Spans of 130 and 80 feet (40 and 24.6 meters) respectively on each side of an intermediate pier.

Continuous-span bridge to span these gaps must carry class 50 loads in normal crossing.

Required:

Determine bridge assembly needed.

Determine type of rocker bearing to use.

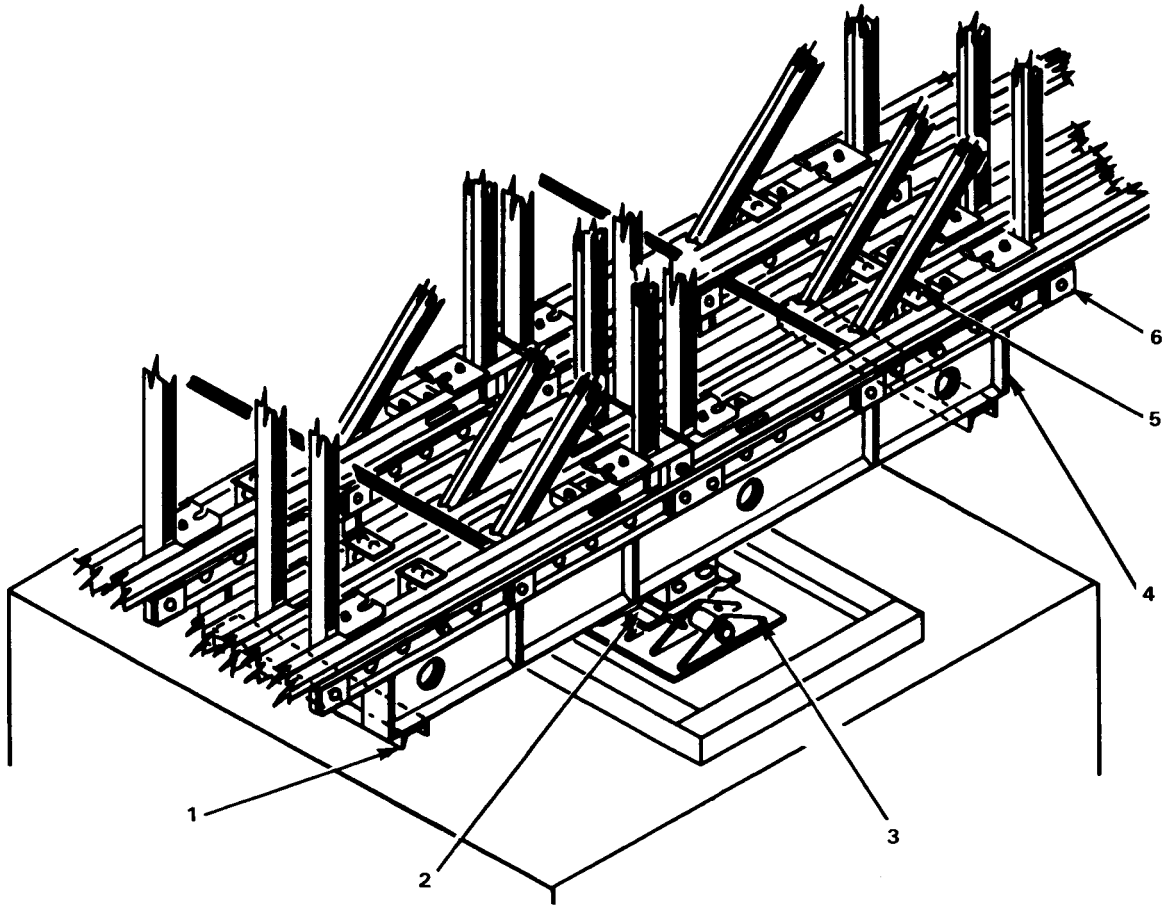
Determine load on pier.

Solution:

Table 16-3 shows that *double-double* truss construction will provide desired class loading.

Table 16-4 shows three panel-support points are required for two equal spans of 130 feet (40 meters) using *double-double* construction. Since the 80-foot (24.6 meters) *double-double* span is not given, the 100-foot (30.8 meters) *double-double* span is used because this is the maximum reaction that can be generated on a *double-double* truss. The panel-support points required are again three; therefore, truss of the girder must be supported under three panel-support points (use bearing shown in Figure 16-15).

Table 16-4 shows the pier reaction is 194 tons (176.5 metric tons) for two equal spans of 130 feet (40 meters) using *double-double* construction. Again, since the 80-foot (24.6 meters) *double-double* span is not shown, the length is taken as the worst condition, in this case 100-foot (30.8 meters) *double-double* construction. The reaction under



1 CHANNEL WELDED TO TRANSOM SECTION UNDER EACH TRUSS
2 CRIB BEARING WELDED TO TRANSOM
3 STANDARD BEARING
4 TRANSOM SECTION WELDED TO CRIB CAPSILL
5 CHORD CLAMP
6 CRIB CAPSILL

Figure 16-16 ***Rocker bearing to support*** *five* ***panel-support points*** *made from crib capsill, transom section, and crib bearing*

two such spans is given as 226 tons (205.7 metric tons). The average of these two spans is used to determine the pier loading, which in this instance is 210 tons (191.1 metric tons).

Note: One advantage of continuous-span bridges over broken-span bridges is shown by the example problem for finding pier reaction of a broken-span bridge given earlier in this chapter. Span lengths and class requirements are identical; however, in broken-span construction a total of 15 bays of *triple-double* and 6 bays of *double-single* construction are required to obtain class 50/55. In continuous-span construction, a total of 21 bays of *double-double* construction will suffice and provide class 60/65. Assuming panels are a critical item, the continuous-span bridge is more economical since it requires only 168 panels, whereas the broken-span bridge requires 204 panels.

Another example of the use of Table 16-4 is as follows:

Given:

Spans of 80 and 120 feet (24.6 and 36.9 meters) respectively on each side of an intermediate pier with *triple-single* truss assembly and class 30 overall.

Required:

Determine type of rocker bearing.

Determine load on pier.

Solution:

Three panel-support points must be used (Table 16-4). Use bearing shown in Figure 16-16 to support pier load.

Load on pier from two 80-foot (24.6 meters) *triple-single* bridges is 167 tons (152 metric tons) and load on pier from two 120-foot (36.9 meters) *triple-single* bridges is 127 tons (115.6 metric tons). The average of the two is 147 tons (133.8 metric tons).

METHODS OF LAUNCHING

Continuous-span bridges are launched by cantilevering the entire bridge with launching nose over the gap or by floating intermediate spans into position and then pinning.

When launching with launching nose (Figure 16-17), the length of launching nose required is the same as for a simple-span bridge of the same length as the longest span in the continuous-span bridge. Use launching links to compensate for sag. When estimating sag in nose to determine position of links, allow an extra 6 inches (15.3 centimeters) of sag for safety. The launching procedures are as follows:

- Use plain rollers as in a single-span bridge. Place rocking rollers at each abutment and on top of each intermediate pier.

Note: The quantity of rocking rollers on top of each intermediate pier is equal to the near-shore requirement.

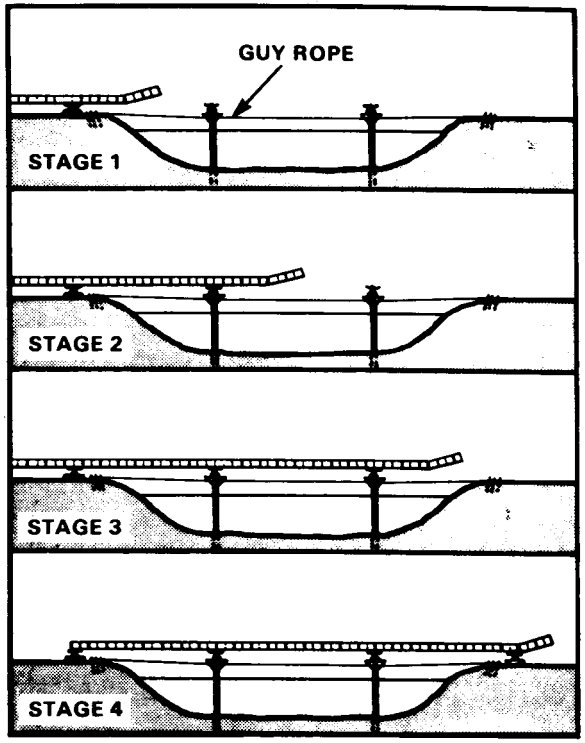


Figure 16-17 Launching a continuous-span bridge over intermediate supports with launching nose

Place rollers on intermediate piers in the same plane as near- and far-shore rollers, and spike or lash them to piers. Check level and alignment of rollers before starting bridge assembly.

- For long bridges, mechanical power may be needed to launch the bridge. Use methods described in Chapter 7. In addition, or as an alternative, use winch on far shore to pull bridge across gap. Careful alignment of bridge during early stages of launching is important.

- Long, heavy bridges can be launched incompletely to make the launching easier. Add extra trusses and decking needed to complete bridge after it is launched.
- During launching, use guy lines to counteract forward thrust of launching. When bridge is completely launched, pull back slightly to relieve stress in guy lines if necessary.

When launching by flotation, float intermediate spans into position, as described in Chapter 18. Lower and then pin to adjacent spans.

METHODS OF JACKING

Jack down shore ends of bridges with jacks under end posts, as described in Chapter 6. At intermediate piers, use expedient jacking methods. Jacking load on toe of each jack must not exceed 7 1/2 tons (6.8 metric tons); jacking load on top, 15 tons (13.6 metric tons). Also, jacks operated in unison must be of the same manufacture. Figures 16-18 and 16-19 show two methods of jacking at intermediate piers. Table 16-1 gives lengths of adjacent spans of continuous-span bridges that can be jacked with these arrangements. The two methods are as follows:

- Use two jacks, one on each side of trusses, under a section of transom under top chords of lower story (Figure 16-18). A soft metal plate between jack head and transom eliminates danger of jack head slipping. Place transom section close to verticals of panels. Block under jacks to raise transom sections to level of top chord.
- Arrange six jacks under ramp section placed across underside of bottom chords (Figure 16-19).

SAMPLE PROBLEM

Given:

Spans of 80 and 120 feet (24.6 and 36.9 meters) over an intermediate pier with *triple-single* truss assembly.

Required:

Determine number of jacks required to jack down bridge.

Solution:

First select method to be used over pier. The method used in Figure 16-18 is the best one because it makes maximum use of mechanical advantage of jack.

Table 16-1 indicates four jacks are required under trusses at each side of bridge.

Total number of jacks required for the pier is 4 + 4 = 8 jacks.

MAINTENANCE

Pier sinking causes increased stress in the bridge and must be checked immediately by blocking or wedging under bridge bearings. Check ends of short spans for any tendency to lift off bearings. If end posts do lift off bearings, lash posts to bearings or break short end span at pier. Check anchorage to keep bridge from creeping under traffic. Maintain blocking to prevent lateral movement on piers.

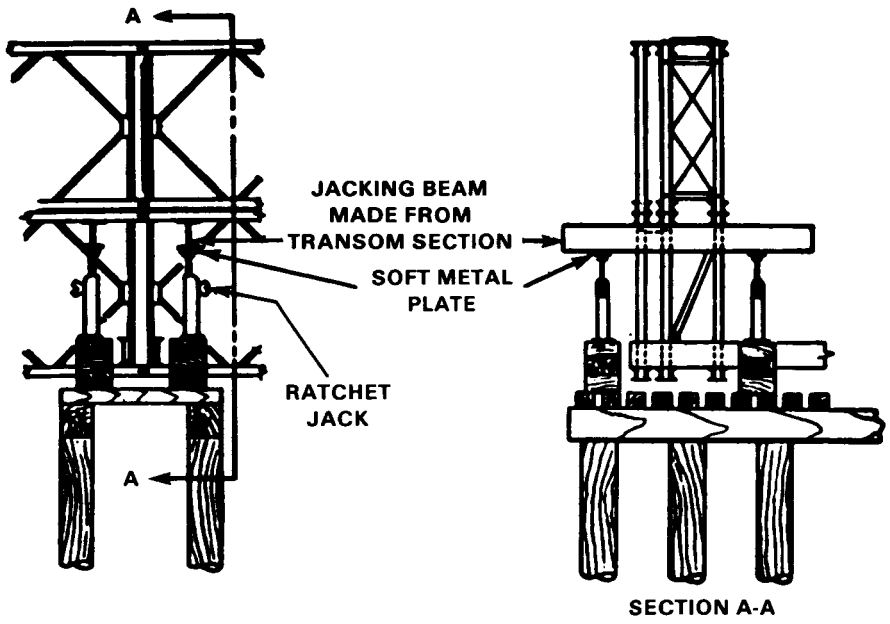


Figure 16-18 ***Jacking over intermediate pier****—two jacks, one on each side of girder, push on beam under top chord of lower story*

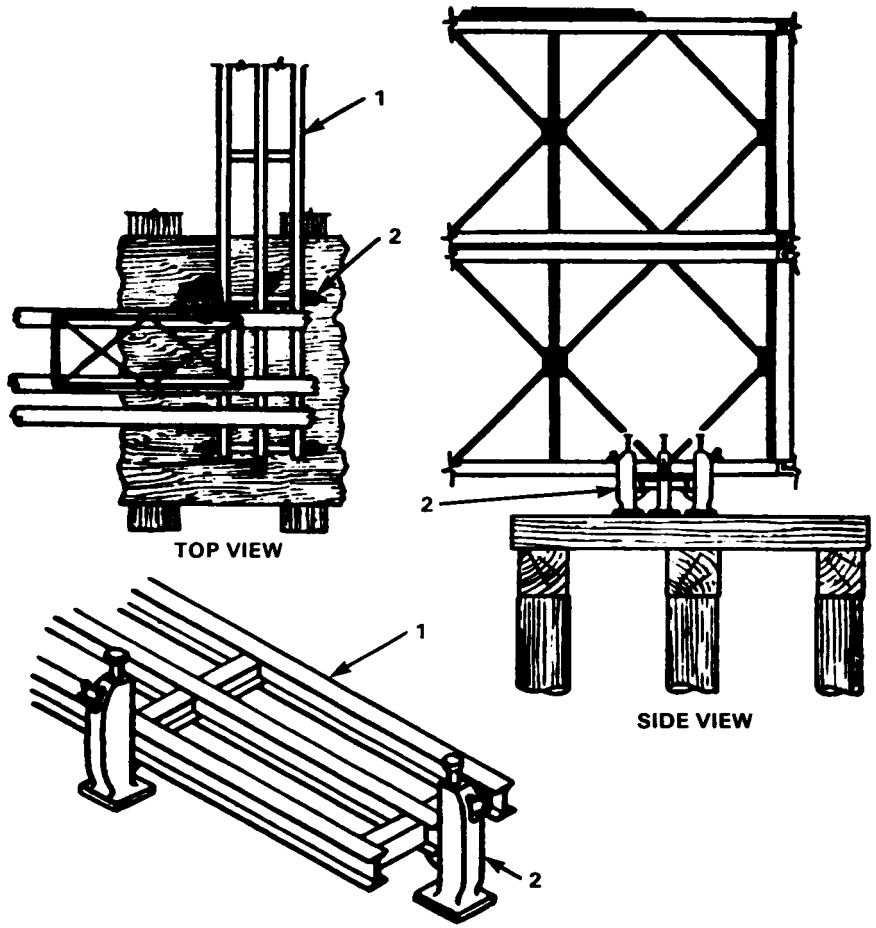


Figure 16-19 ***Jacking over intermediate pier****—six ratchet jacks arranged under ramp section under lower chord of trusses*

CANTILEVER-SPAN BRIDGES

USES

It is possible to use cantilever construction to produce clear span lengths greater than those obtained with conventional through-type construction. A clear span of 400 feet (123.1 meters) can be obtained using cantilever construction, but this span requires the use of 20 trusses, which is excessive and which would become too cumbersome. The design data and information contained in this section are based on cantilever construction, as shown in Figure 16-20.

DESIGN

The following design features are assumed:

- Tables 16-5, 16-6, and 16-7 (page 208) are based on a class 60 live load on a single lane, with a 14-foot (4.3 meters) roadway. The dead load is based on a panel weight with bracing of 600 pounds (272.7 kilos) and an 8-inch (20.4 centimeters) wooden flooring weighing 400 pounds (181.8 kilos) per foot. A single-story truss was assumed capable of resisting 380 foot-tons, a double-story truss 700 foot-tons, and a triple-story truss 1,310 foot-tons.
- An impact equal to 15 percent of the live load was used.
- The minimum number of trusses in both the simple span and the cantilever span was set at four. If less than four trusses are used, the allowable capacities must be decreased due to excessive concentration of wheel loads on a truss, and the type of floor must be changed.
- The maximum number of trusses was taken at 10.
- The single-axle load equivalents (SALE) charts for moment and shear have been used for those spans on which wheeled vehicles governed. Appendix C describes in detail the use of SALE charts in determining moment and shear. For spans of 120 feet (36.9 meters) and above, the critical vehicle is the 60-ton (54.6 metric tons) tracked vehicle. A spacing of 100 feet (30.8 meters) from front to rear of a convoy of tanks moving across the spans gives a center of gravity of the loads at

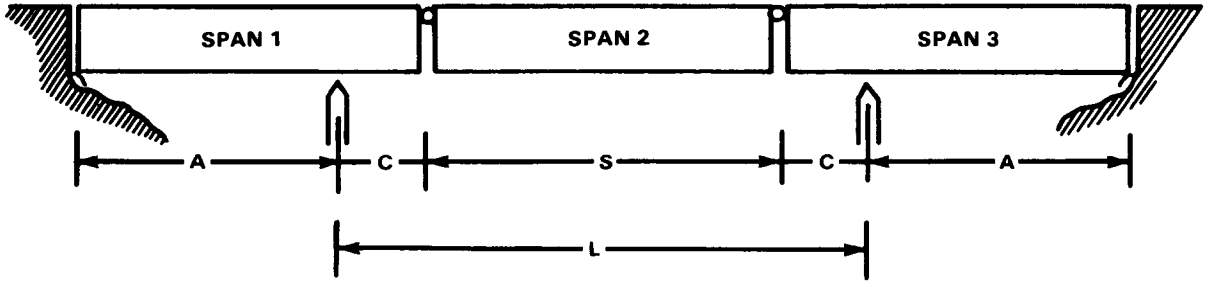


Figure 16-20 ***Cantilever construction***

Table 16-5 ***Number of trusses required for*** *simple suspended* ***span (Figure 16-20)***

SPAN (ft)	TRUSSES	MAX END REACTION— TONS LL + I + DL	PANELS REQUIRED
SINGLE-STORY CONSTRUCTION			
80	4	81.8	32
90	5	84.7	45
100	6	88.0	60
110	7	91.6	77
120	8	98.9	96
130	9	108.0	117
140	10	116.7	140
DOUBLE-STORY CONSTRUCTION			
120	4	98.9	96
130	5	110.0	130
140	6	121.0	168
150	6	127.5	180
160	7	139.5	224
170	8	152.2	272
TRIPLE-STORY CONSTRUCTION			
180	5	147.4	270
190	5	153.3	285
200	6	168.1	360
210	7	184.0	441
220	8	200.7	528
230	9	218.4	621
240	10	236.9	720
250	11	256.1	825
260	13	289.0	1,014
270	18	836.4	1,296
280	20	397.8	1,680

Table 16-6 Number of trusses required in suspended and cantilever spans (Figure 16-20)

L	S	TRUSSES IN SPAN 2 NUMBER	TRUSSES IN SPAN 2 TYPE (STORY)	TRUSSES IN SPANS 1, 3 NUMBER	TRUSSES IN SPANS 1, 3 TYPE (STORY)	C	A MAX	A MIN	MIN NUMBER OF PANELS
100	80	4	S	4	S	10	80	80	104
110	90	5	S	4	S	10	80	80	117
120	100	6	S	5	S	10	90	80	130
130	110	7	S	5	S	10	90	80	167
140	120	8	S	5	S	10	90	90	136
150	130	9	S	5	S	10	90	90	217
160	140	10	S	5	S	10	90	90	240
170	150	4	T	6	S	10	110	90	260
180	160	4	T	6	S	10	110	100	294
190	170	4	T	6	S	10	110	100	336
200	180	5	T	6	S	10	110	100	402
210	190	5	T	6	S	10	110	100	417
220	200	6	T	7	S	10	130	100	514
230	190	5	T	10	S	20	160	100	586
240	220	8	T	7	S	10	130	110	686
250	230	9	T	7	S	10	130	120	789
260	200	6	T	5	T	30	210	140	870
270	190	5	T	6	T	40	230	150	963
280	200	6	T	6	T	40	230	160	1,060
290	210	7	T	7	T	40	240	160	1,239
300	200	6	T	9	T	50	260	160	1,440
310	190	5	T	10	T	60	270	160	1,606

114 feet (35.1 meters) center to center, and this was the maximum load used.

- A minimum safety factor of 1.15 ***was*** **used** against overturning of the cantilever span (c).

The following tables should be used

- Table 16-5 gives the required number of triple-, double-, and single-story trusses which were used for the simple suspended span (S).
- Table 16-6 gives the various spans which can be built-using cantilever-type construction. The combination shown is the most economical based on the number of panels required for the center-to-center pier spans (L) using the minimum length of anchor arm. It is important to note that there is both a maximum and a minimum length of anchor arm. The minimum length of anchor span (A) provides the necessary counterweight for the cantilever arm, and the bridge is stable if built in this way. However, the positive resisting moment of the counterweight span is not being used to its full capacity. The maximum span length shown provides for this use but, if this length is exceeded, even with proper loading, the section may fail.
- Table 16-7 gives combinations with the same number of trusses in both the cantilever and the suspended spans. These combinations are not as economical as those in Table 16-6.

The following is a design example:

Step 1: Design of suspended span(S) (Figure 16-20).

Assume S = 190 ft
SALE = 66.7 tons
MLL = PL/4
= 66.7 x 190/4
= 3,170 ft-tons
$M_{LL} + M_I$ = 3,170 x 1.15
= 3,650 ft-tons

Estimated triple-story trusses = 5
M_{DL} = [5(.09) + .2] 1902/8
= 2,930 ft-tons
M_{TOT} = 6,580 ft-tons
Actual number of trusses required=
6,580/1,310 = 5
Therefore, 5 triple-story trusses will be used.

Maximum end shear:
LL+ I = 84 + .15 (84)
= 96.6 tons
DL shear = 61.7 tons
$Shear_{TOT}$ = 96.6+ 61.7
= 158.3 tons

Step 2: Design of cantilever span (C) (Figure 16-20).

Assume single-story construction with 6 trusses
Try 10-ft span:
Resisting moment = 6 x 380
= 2,280 ft-tons
M_{DL} = [6(.03) + .2] 10^2 / 2
= 19 ft-tons
End shear (on hinge) possible:
P(10) = 2,280-19
= 2,261 ft-tons
P = 2,261 / 10
= 226.1 tons.
Therefore, this construction and span length is suitable to carry end shear of suspended span of 118 tons.

Step 3: Design of minimum anchor span (A) (Figure 16-20).

W = 6(.03) + .2
= .38 ton / ft

$$\frac{wA^2}{2} = 2{,}280 \text{ ft-tons}$$

Table 16-7 Number of trusses required in suspended and cantilever spans—using equal number in both—(Figure 16-20)

L	S	TRUSSES IN SPAN 2 NUMBER	TRUSSES IN SPAN 2 TYPE (STORY)	TRUSSES IN SPANS 1, 3 NUMBER	TRUSSES IN SPANS 1, 3 TYPE (STORY)	C	A MAX	A MIN	MIN NUMBER OF PANELS
100	80	4	S	4	S	10	80	80	104
110	90	5	S	5	S	10	90	80	135
120	100	6	S	6	S	10	100	80	168
130	110	5	D	5	S	10	90	90	210
140	120	5	D	5	S	10	90	90	220
150	130	5	D	5	S	10	90	90	230
160	140	6	D	6	S	10	110	90	288
170	150	6	D	6	S	10	110	90	300
180	140	4	T	4	D	20	130	120	392
190	150	4	T	4	D	20	130	120	404
200	160	4	T	4	D	20	130	120	416
210	170	5	T	5	D	20	150	120	538
220	180	5	T	5	D	20	150	130	570
230	190	5	T	5	D	20	150	130	585
240	200	6	T	6	D	20	160	130	720
250	190	5	T	5	T	30	210	140	795
260	180	6	T	6	T	40	230	150	1,008
270	190	6	T	6	T	40	230	150	1,026
280	200	6	T	6	T	40	230	160	1,080
290	210	7	T	7	T	40	240	160	1,281
300	220	8	T	8	T	40	250	160	1,486
310	230	9	T	9	T	40	260	160	1,701
320	240	10	T	10	T	40	270	160	1,920

(R_1 assumed= 0)

A = 2,280 X 2 / .38
= 12,000
A = 109.5 ft (try 100 ft)

Overturning moment about R2

$$= \frac{wC^2}{2} + PC$$

= 19 + 158.3(10)
= 1,602 ft-tons

Resisting moment about R_2

$$= \frac{wA^2}{2}$$

$$= \frac{.38(100)^2}{2}$$

= 1,900 ft-tons

Safety factor = 1,900 / 1,602
= 1.18
(within 1.15 assumed allowable)
Therefore, minimum A = 100 ft (30.48m)

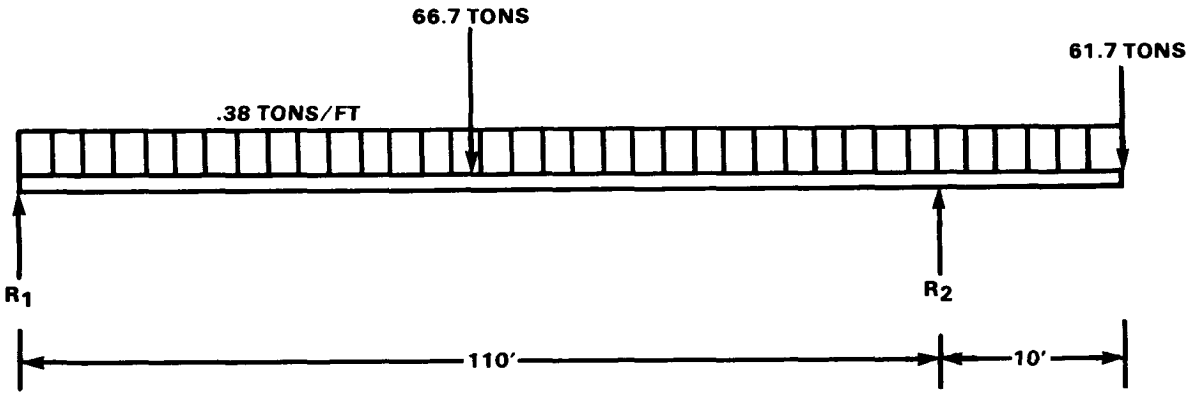


Figure 16-21 ***Loads and reactions***

Step 4: Design of maximum anchor span (A) (Figure 16-21).

Maximum resisting positive moment
= 2,280 ft-tons
Assume span = 110 ft

$$SALE + SALE_1$$
$$= 58 \times 1.15$$
$$= 66.7 \text{ tons}$$
$$R_1 = 66.7(55) - (61.7 \times 10) + \frac{(.38 \times 110 \times 55) - (.38 \times 10 \times 5)}{110}$$
$$= 48.4 \text{ tons}$$

Moment at center
$$= (48.4 \times 55) - \left[.38 \times \frac{(55^2)}{2}\right]$$
$$= 2{,}087 \text{ ft-tons}$$

Therefore, maximum A = 110 ft (33.53m)

Therefore, the total maximum length of bridge for this combination is:

$$S+2(C)+2(A) = 190+20+220$$
$$= 430 \text{ ft } (131.06\text{m})$$

The pier-to-pier span length:

$$L = S+2(C)$$
$$= 190+20$$
$$= 210 \text{ ft}$$
(64.0lm) (Table 16-7)

Note: Although six single-story trusses would be able to carry more than the maximum end shear of 158.3 tons (144.1 metric tons) on a cantilevered 10-foot span, an examination of steps 3 and 4 shows they are needed for even the minimum length of anchor span required.

CHAPTER 17
PANEL CRIB PIERS AND TOWERS

Panel crib piers are made of trusses with panels set horizontally or vertically and are normally braced with transoms, sway bracing, rakers, bracing frames, and tie plates in a panel bridge.

Panel crib piers assembled from parts of the Bailey bridge set can be used as—

- Intermediate supports for through- and deck-type fixed bridges. The piers can be set on timber grillage, piles (Figure 17-1), masonry footings (Figure 17-2), or partially demolished piers.
- Piers in barge bridges.
- Intermediate landing-bay piers in floating panel bridges with double landing bays.
- Expedient towers for suspension bridges, lift bridges, gantries, and floating-bridge anchor-cable systems.
- Expedient marine piers.

CHARACTERISTICS OF CRIBS

Types of panel crib piers have their own distinguishing characteristics. Panel crib piers are described by the number of trusses (single, double, triple, and so on, as in a panel bridge); the number of stories (number of panels along the vertical axis in one bay, as in the panel bridge); the number of bays (number of panels along the horizontal axis in a given story); and the position of panels in each story (horizontal or vertical). Table 17-1 (page 212) lists the abbreviations used to describe typical panel crib piers. Panel cribs have from one to four trusses on each side, depending on the desired capacity. There must always be at least as many trusses in the crib as in the bridge it supports.

Panels in a panel crib pier are horizontal (Figure 17-3, page 212) or vertical (Figure 17-4, page 213). Horizontal panels provide a 5-foot 1-inch (.16 meter) increment in pier height. They are, however, weak laterally and are used one above the other when expedient bracing is added. When ultimate capacity piers are used, any horizontal stories are weaker than vertical ones. Vertical panels provide 10-foot (3.1 meters) increments in pier height. They can be used one above the other in piers up to 70 feet (21.5 meters) high supporting continuous spans and up to 110 feet (33.8 meters) supporting broken spans. In high piers, exceeding three vertical stories,

Figure 17-1 ***Two continuous-panel bridges with panel crib piers on pile piers***

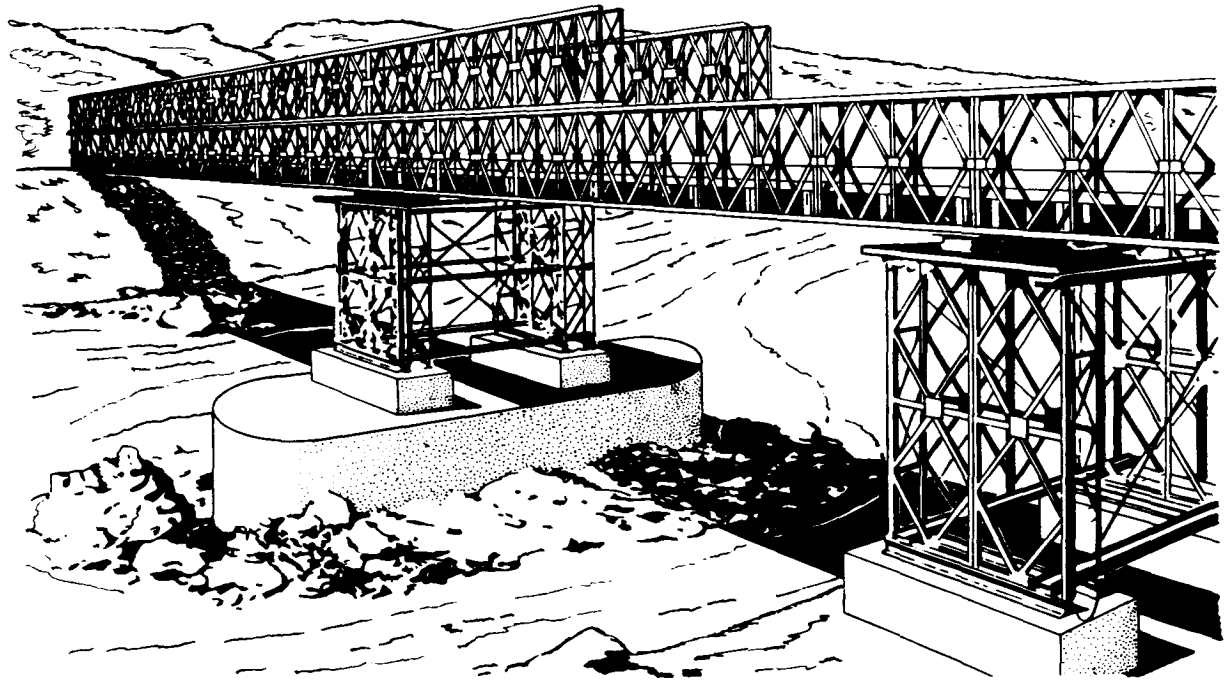


Figure 17-2 ***Continuous-panel bridge with panel crib piers on concrete footings***

the pier base must be doubled for at least half its height or the lower story must be imbedded in concrete for ¾ of its height.

To assemble 15-, 25-, 35-, 45-, 55-, and 65-foot (4.6, 9.1, 10.8, 13.8, 16.9, and 20 meters) piers, vertical stories are used with only one 5-foot (1.5 meters) horizontal story placed at the top of the crib.

TYPES OF BRIDGE SEATING

Seating for a continuous bridge is different than that for a broken-span bridge. Continuous-bridge seating includes the following features:

- Deflection of a span under load tends to change the slope of the bridge at the piers. To prevent large stresses in the bridge and pier, allow some rocking movement at intermediate supports of continuous bridges.

  A rocker at top of the crib can be built of crib bearings on standard bearings, inverted junction-link bearings on junction links, or one or two I-beams at right angles to the bridge axis. With this type of bridge seating, bottom chords of the bridge over the seating are normally reinforced by a steel beam to distribute the load and prevent failure of the panel chords due to local bending. These rockers are described and illustrated in Chapter 16.

- If the crib is fastened rigidly to the bridge, it must rock with the bridge as the girders deflect under load. A rocker at the base of the crib can be built of crib bearings on standard bearings or inverted junction-link bearings on junction links. This type of pier construction may prove useful on piers less than 10 feet (3.1 meters) wide along the axis of the bridge. It must be built from the bridge downward and the bridge must be capable of holding itself, the pier, and the work crews while resting on rollers for both span lengths until the pier is in position. Heavy bearing plates are needed beneath the crib-bearing so that the entire bridge-pier reaction may be distributed to the pier base.

- As an expedient when rocker bearings cannot be improvised, seat bridge on timber on top of the piers.

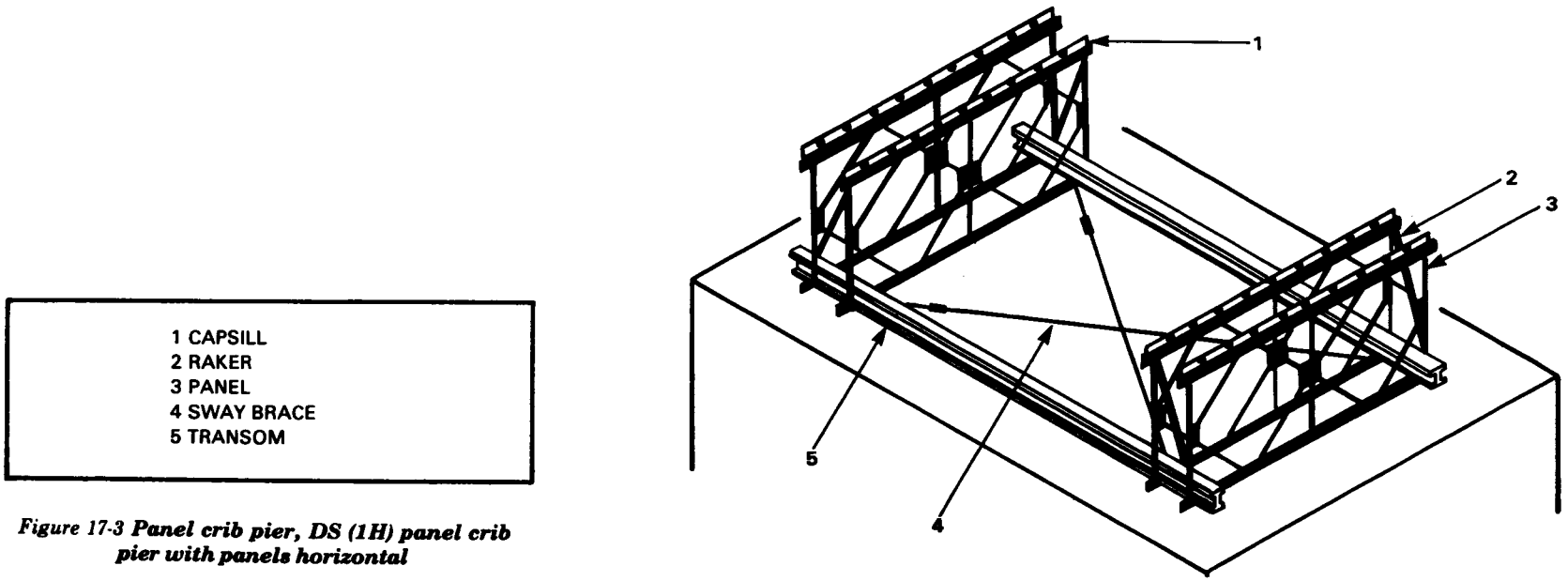
Broken-span bridge seating includes the following features:

- In broken-span assembly, the adjacent ends of the two spans are seated on the junction-link bearings by use of span junction posts and junction links (Figure 17-5, page 214).

- As an expedient, the adjacent ends of the two spans can be pinned to the vertical panels in the pier, or the two ends can rest on separate bearings.

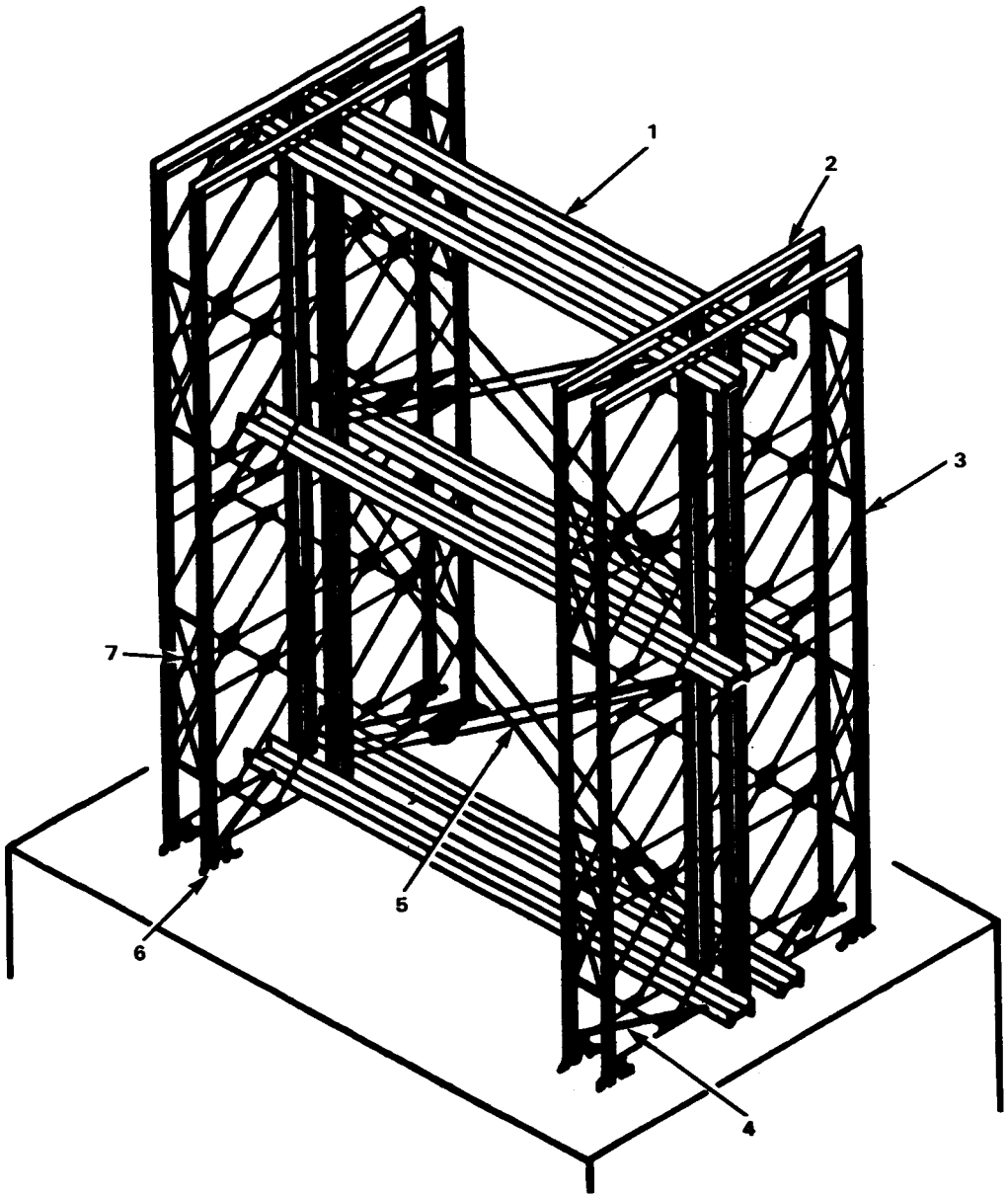
Table 17-1 ***Abbreviations used to describe panel crib piers***

TYPE OF PIER								
NUMBER OF TRUSSES	NUMBER OF STORIES	NUMBER OF BAYS AND PANEL POSITIONS						ABBREVIATIONS
		1ST STORY	2ND STORY	3RD STORY	4TH STORY	5TH STORY	6TH STORY	
Single	Single	One-horizontal						SS (1H)
Double	Single	One-vertical						DS (1V)
Double	Single	Two-vertical						DS (2V)
Triple	Single	Two-vertical						TS (2V)
Quadruple	Double	One-horizontal	One-vertical					QD (1H-1V)
Double	Double	One-vertical	One-vertical					DD (1V-1V)
Double	Double	Two-vertical	One-horizontal					DD (2V-1H)
Double	Double	Two-vertical	One-vertical					DD (2V-1V)
Double	Double	Two-vertical	Two-vertical					DD (2V-2V)
Quadruple	Double	Two-vertical	Two-vertical					QD (2V-2V)
Triple	Triple	Two-vertical	Two-vertical	Two-vertical				TT (2V-2V-2V)
Double	Quadruple	Four-vertical	Four-vertical	Two-vertical	Two-vertical			DQ (4V-4V-2V-2V)
Triple	Five	Four-vertical	Four-vertical	Two-vertical	Two-vertical	Two-vertical		T5(4V-4V-2V-2V-2V)
Triple	Six	Two-vertical	Two-vertical	Two-vertical	Two-vertical	Two-vertical	Two-vertical	T6(2V-2V-2V-2V-2V-2V)



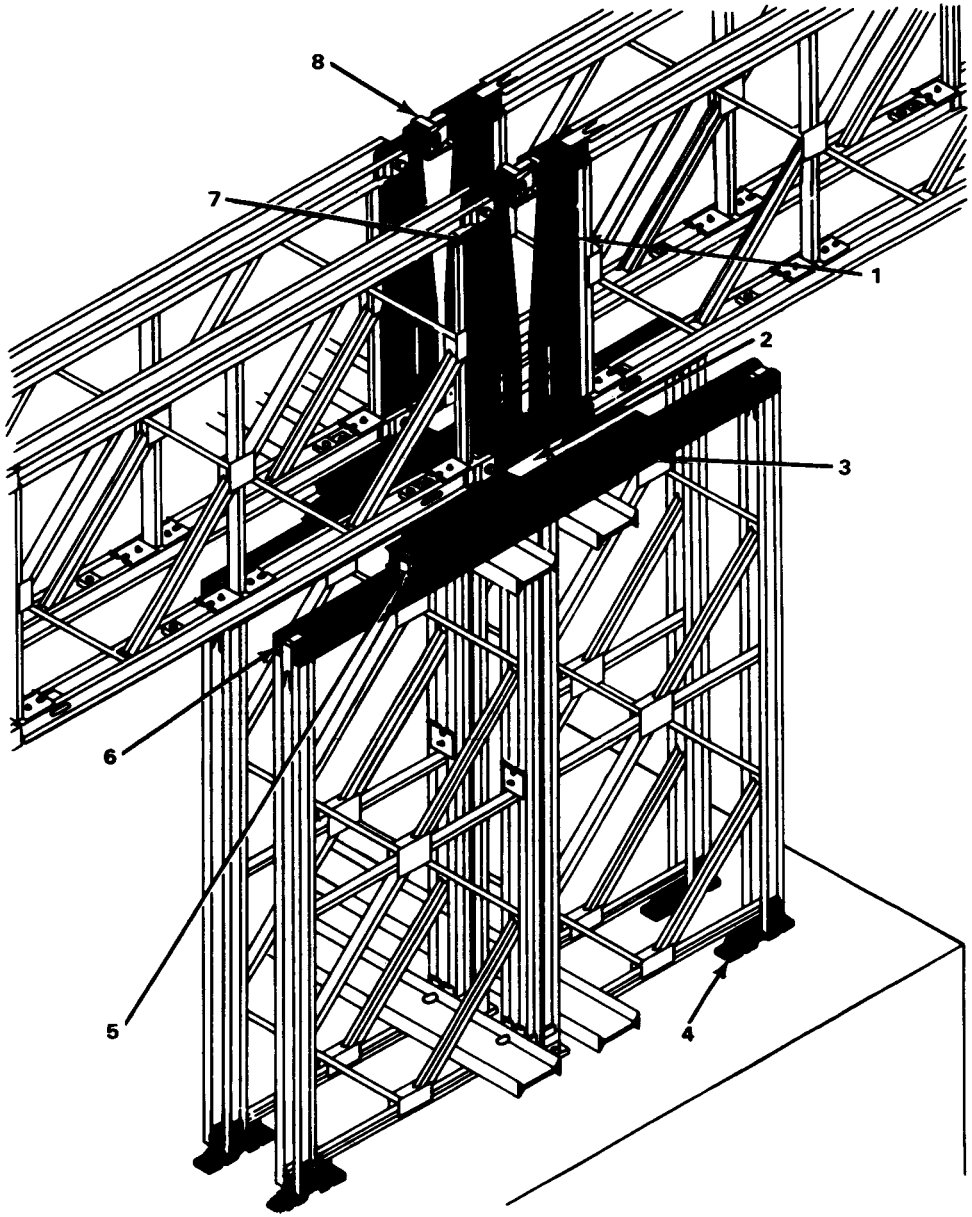
1 CAPSILL
2 RAKER
3 PANEL
4 SWAY BRACE
5 TRANSOM

Figure 17-3 ***Panel crib pier, DS (1H) panel crib pier with panels horizontal***



1 TRANSOM
2 CAPSILL
3 PANEL
4 RAKER
5 SWAY BRACE
6 CRIB BEARING
7 BRACING FRAME

*Figure 17-4 **Panel crib pier, DD (2V-2V) panel crib pier with panels vertical***



1 FEMALE SPAN JUNCTION POST
2 JUNCTION LINK
3 JUNCTION-LINK BEARING
4 CRIB BEARING
5 CHORD CLAMP
6 CRIB CAPSILL
7 MALE SPAN JUNCTION POST
8 LAUNCHING LINK MK II
(REMOVED AFTER LAUNCHING)

Figure 17-5 ***Construction of typical panel crib pier showing use of special panel-crib parts***

Table 17-2 ***Major parts of the bridge conversion set No. 3, Bailey type, panel crib pier, fixed M2***

ITEM	WEIGHT (lb)
Female span junction post	202
Male span junction post	194
Junctin chess	149
Junction link	36
Junction-link bearing	217
Chord clamp	11
Crib capsill	251
Crib bearing	37

SPECIAL PARTS FOR PANEL CRIB PIERS

The bridge conversion set No. 3, Bailey type, panel crib pier, contains parts that are used with equipment from the basic bridge set to build panel crib piers. The major items in the conversion set are listed in Table 17-2.

SPAN JUNCTION POSTS

Span junction posts are special end posts for connecting adjacent ends of two spans and supporting them on the same bearing.

There are two types of span junction posts, male and female, which have lugs that are pinned to female and male ends, respectively, of standard panels. At the junction, each post has two other connecting lugs, a male and female lug at the top according to type, and a universal jaw at the base. Irrespective of type, two posts can be connected at the base by a normal panel pin. Always use a bridge pin retainer on the panel pin at this joint. An intermediate pin hole and recess in the base of each post is for the junction link.

During launching, connect the top lugs of the posts by a launching-nose link Mk II. The link will fit only between one female span junction post and one male span junction post, so take care when constructing the two spans to keep all the male lugs on the panels faced the same way. After the bridge is jacked down and posts are pinned to the junction link, remove the link; leave in the pin joining the two posts at their base. Then the gap between the two lugs of the posts allows an upward slope of 1 to 6.7 or a downward slope of 1 to 5 in one span when the other is level.

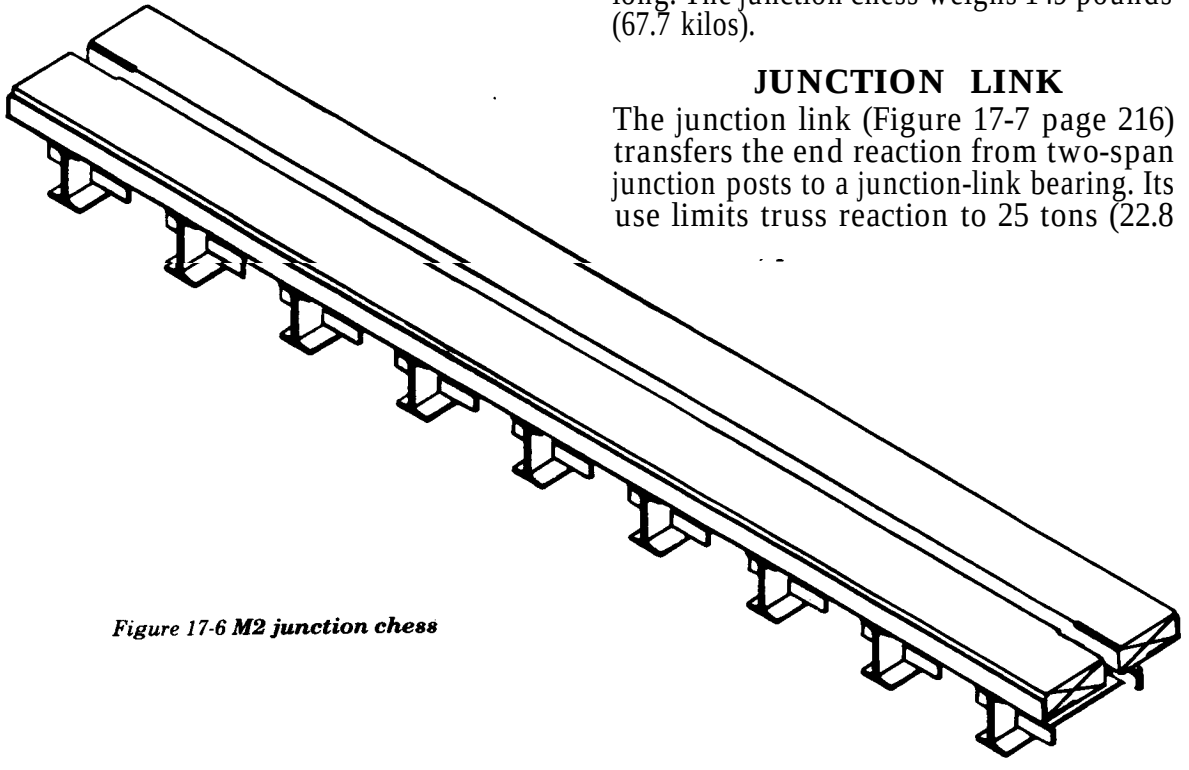


Figure 17-6 ***M2 junction chess***

The female span junction post weighs 202 pounds (91.8 kilos) and the male span junction post weighs 194 pounds (88.2 kilos).

M2 JUNCTION CHESS

Junction chess (Figure 17-6) span the gap in the bridge deck between the ends of the two spans connected by span junction posts. Four junction chess are used at each span junction.

The junction chess consists of two 6-foot 10 ½-inch (2.1 meters) timbers fastened to nine steel I-beams 11½ inches (29.3 centimeters) long. The junction chess weighs 149 pounds (67.7 kilos).

JUNCTION LINK

The junction link (Figure 17-7 page 216) transfers the end reaction from two-span junction posts to a junction-link bearing. Its use limits truss reaction to 25 tons (22.8

The junction link is a triangular-shaped steel assembly with two projecting male lugs on its top side spaced to pin with panel pins to the two-span junction posts. Both holes are elongated to permit some play in the joint. A bridge pin retainer must always be used on the panel pins at this joint. The bottom of the junction link tapers down to a nose with a tubular bearing which seats in the curved bearing plate of the junction-link bearing. The junction link weighs 36 pounds (16.4 kilos).

JUNCTION-LINK BEARING

The junction-link bearing (Figure 17-8) is used under the junction link which supports the ends of the bridge. It can be used in the following ways:

- When supported by a vertical panel, if male lugs of panel are uppermost, pin jaws of the junction-link bearings to the panel lugs. If female lugs are uppermost, rest jaws of junction-link bearing on top of lugs and fasten them by chord clamps.
- When supported by a crib capsill (Figure 17-5), secure it to the capsill with chord clamps.
- When supported by a crib bearing, pin bearing to two center holes of junction-link bearing with panel pins.
- When used under female end of vertical panel, rest female lugs of panel on jaws of junction-link bearing and secure them by chord clamps.
- When supported by timber, lay junction-link bearing directly on a timber support.

The junction-link bearing is made of two 8-inch (20.4 centimeters) channels welded back to back with the same spacing as between channels in the chords of the panel. It is 5 feet 1 inch (1.6 meters) long and has female jaws at each end. The distance between panel-pin holes in the female jaws is 4 feet 9 inches (1.5 meters), the same as vertical distance between pin holes in the pane). Between the webs of the channels in the center of the junction-link bearing is a curved bearing plate on which the junction link bears. There is a hole through the webs of the channels just above the curved bearing plate for a captive pin which locks the junction link in place. There are two panel-pin holes in the webs of the channels beneath the curved bearing plate. They are used to pin the crib bearing which fits in the recess between the channels. A junction-link bearing weighs 217 pounds (99.3 kilos). Its maximum capacity is 25 tons (22.8 metric tons) (Table A-14, Appendix A).

CHORD CLAMP

The chord clamp (Figure 17-9) is used to pin—

- Crib capsill to panel chord (Figure 17-10). Chord clamps are pinned to any of the holes in the capsill.
- Crib capsill to female jaw of panel.
- Crib capsill to junction-link bearing (Figure 17-5).

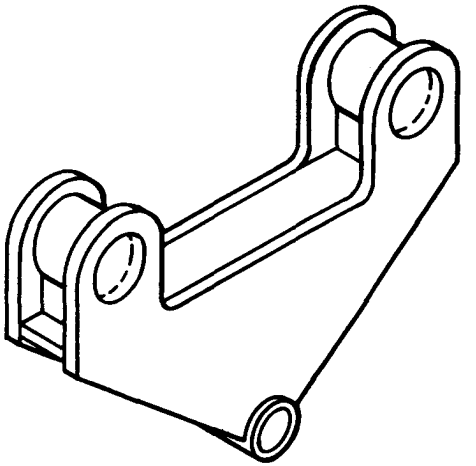


*Figure 17-7 **Junction link***

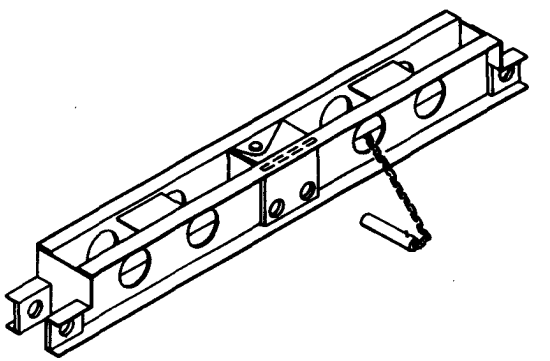


*Figure 17-8 **Junction-link bearing***

- Junction-link bearing to female jaw of panel.

The chord clamp is in effect a double-length male lug with two panel-pin holes and a T-head. Slip the clamp between chord channels of a panel until the head bears on the channel flanges; then pin the clamp to a crib capsill or other female joint with a panel pin. If the

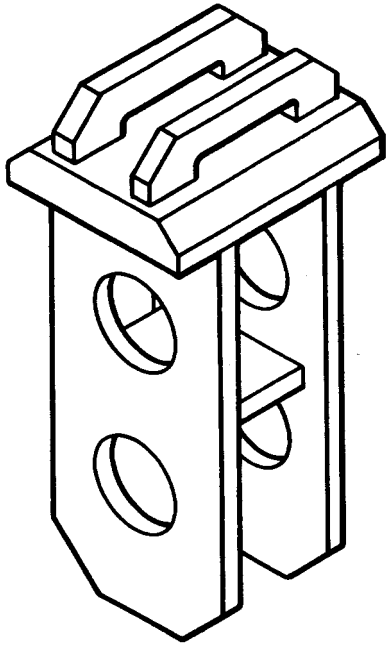


Figure 17-9 Chord clamp

chord clamp is slipped through two adjacent female jaws, pin it to each by panel pins through both holes in the chord clamp. The chord clamp weighs 11 pounds (5 kilos).

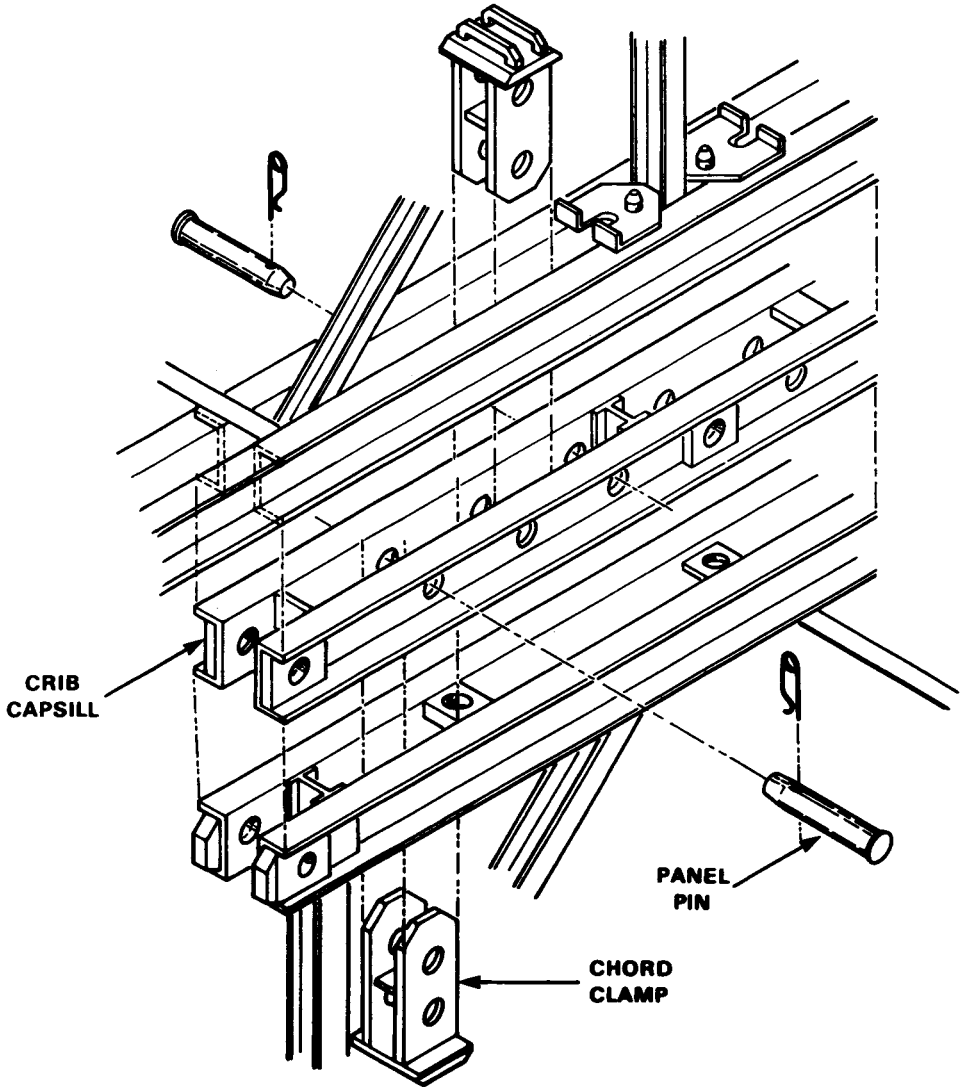


Figure 17-10 Use of crib capsill and chord clamps to connect horizontal panels of bridge and pier

CRIB CAPSILL

The crib capsill (Figure 17-11) distributes the load from the bridge to the main chords of vertical panels or to the three verticals of horizontal panels in a crib. It has unreinforced holes used to take the vertical load. Before panel pins can be inserted in reinforced holes, the holes must be reamed or filed slightly. The reinforced holes are used to pin the capsill to the following:

- Male lugs of single vertical panels.
- Male lugs of two adjacent vertical panels.
- Crib bearing (Figure 17-12).

The crib capsill is made of two 4-inch (10.2 centimeters) channels welded back to back to spacer lugs with the same spacing between channels as in the chord of the standard panel. It is 10 feet 2 inches (3.1 meters) long, and has female jaws at each end. Holes are spaced along the webs of the channels. Six pairs of panel-pin holes are reinforced with steel blocks and spaced so male lugs of two adjacent panels or of a single panel can be connected to the crib capsill with panel pins. Additional unreinforced holes for chord clamps are spaced generally at 6-inch (15.3 centimeters) centers between reinforced holes. Before panel pins can be inserted through the holes they must be reamed or filed slightly. The crib capsill weighs 251 pounds (114.1 kilos).

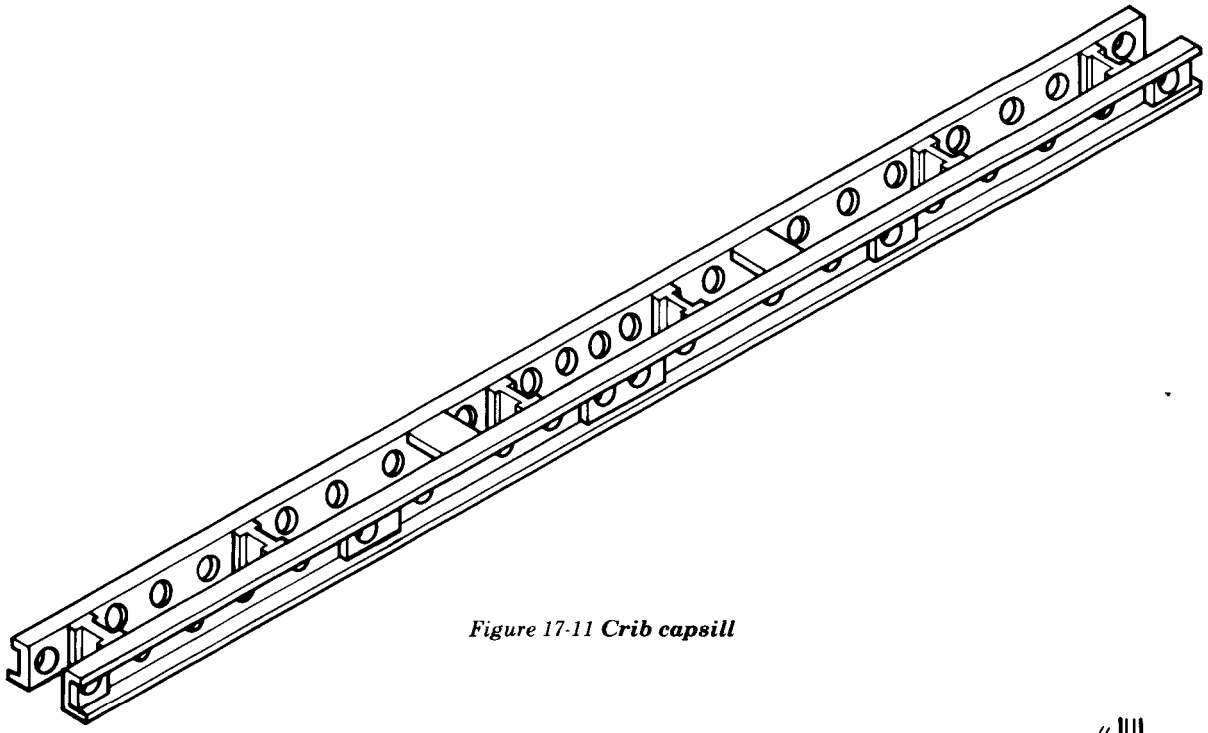


Figure 17-11 ***Crib capsill***

CRIB BEARING

The crib bearing (Figure 17-13) is used as a base of panel cribs and can be pinned with panel pins to the following:

- One female jaw of vertical panel (Figure 17-14).
- Two female jaws of adjacent vertical panels (Figure 17-14).
- Two central holes of a crib capsill (Figure 17-12).
- Two central holes of a junction-link bearing.

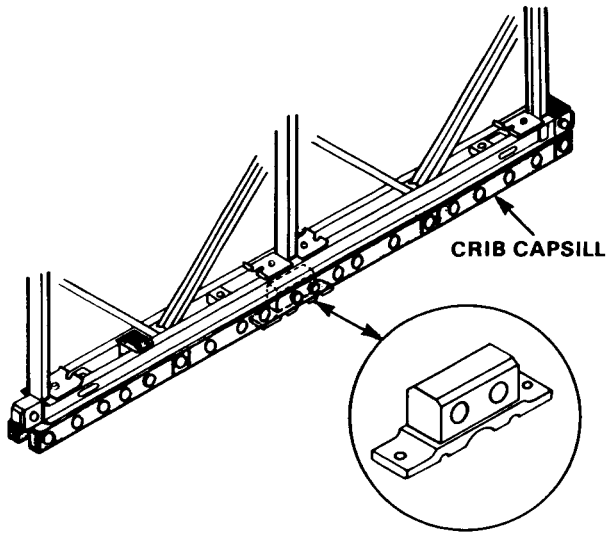


Figure 17-12 ***Crib bearing under crib capsill***

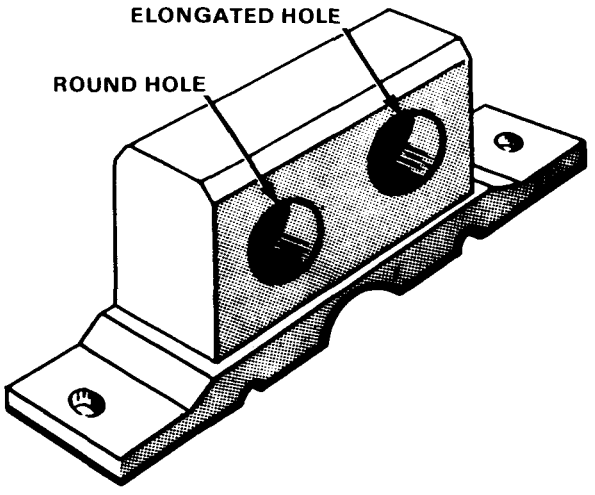


Figure 17-13 ***Crib bearing***

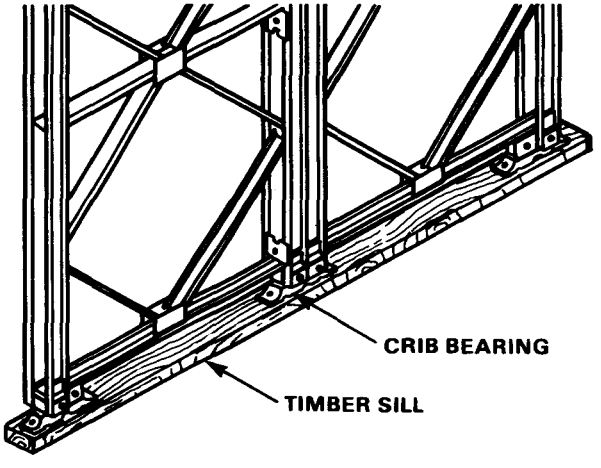


Figure 17-14 ***Crib bearings pinned to one and to two adjacent female jaws or vertical panels, and spiked to timber sill to provide fixed bearing***

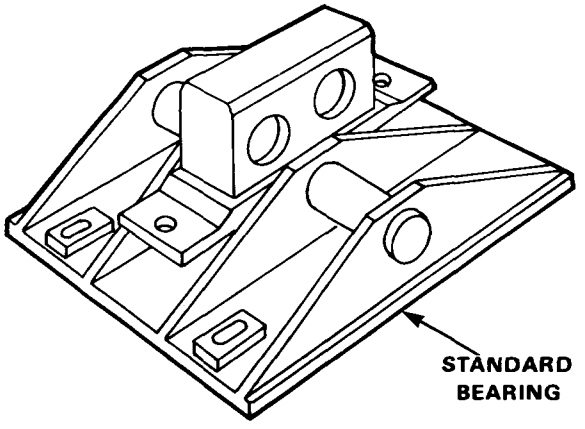


Figure 17-15 ***Crib bearing used with standard bearing to provide rocker bearing***

The crib bearing can be spiked to a timber sill (Figure 17-14) to provide a rigid base or set on a standard bearing (Figure 17-15) to provide a rocker bearing. The bearing area of the pin is 1.875 inches by 3 inches, or 5.625 square inches (36.4 square centimeters).

The crib bearing is in effect a double-length male lug welded horizontally to a base block. One of the pin holes is elongated to make pinning easier when both holes are used. If only one hole is needed, the circular one is used. Holes are provided in the base block of the crib bearing for spiking to a timber sill. The underside of the base block has a semi-circular bearing to seat on a standard bearing. The crib bearing weighs 37 pounds (16.8 kilos).

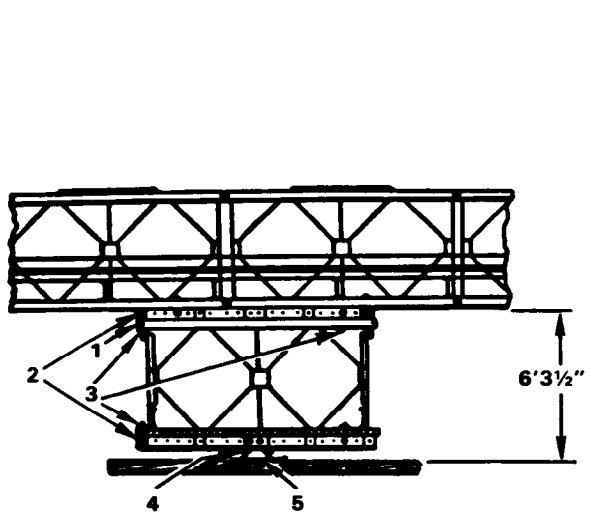
CRIB LOAD AND CAPACITY

The amount of load on and the capacity of a crib must be determined. Chapter 16 describes a method for determining the approximate load transmitted to the crib by the ends of two independent spans. Continuous-span assembly over the pier transmits greater load to the pier. These reactions are listed in Table 16-4.

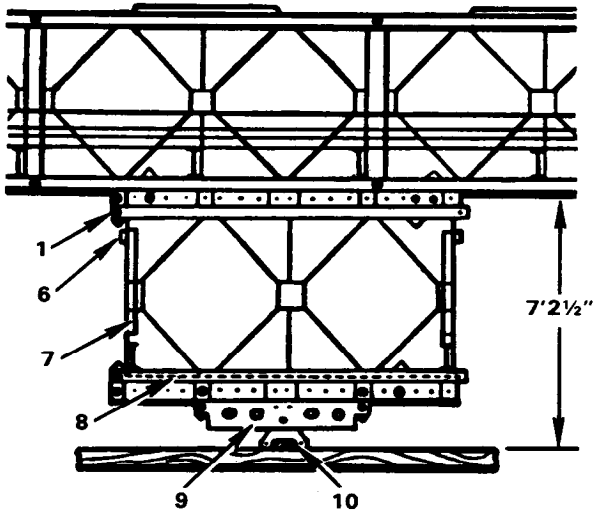
Figures 17-16 and 17-21 (pages 220 and 222) show standard assembly of piers built with special panel-crib parts. Capacities are given in all cases. Single-truss cribs can take 50 percent of the loads given for double-truss cribs with only the inner truss loaded. Use single-truss cribs only for light loads on low cribs. The capacity of panel crib piers is usually limited by the strength of the junction link, junction-link bearing, and crib capsill (Table A-14, Appendix A).

If special panel-crib parts are not used, the load is carried by the top members of vertical panels in the crib. Lay timber on top members of each panel to concentrate load at three points: at the center, and near each end adjacent to the panel chords. With the load applied in this manner, the top member of one vertical panel will carry about 14 tons (12.7 metric tons), and piers with this type of bearing will have the same capacity as piers of corresponding assembly built with special parts (Table 17-3, page 222).

Table A-14, Appendix A gives the strength of the individual panel-crib parts for use in estimating the capacity of expedient panel cribs.



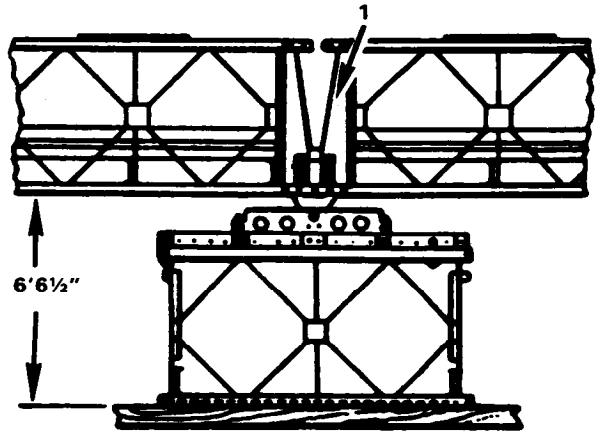
CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	35
ALL TRUSSES LOADED	70
TRIPLE TRUSS	90



CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	50
ALL TRUSSES LOADED	100
TRIPLE TRUSS	145

1 FEMALE END
2 CRIB CAPSILLS
3 CHORD CLAMPS
4 CRIB BEARING
5 STANDARD BEARING AND BASE PLATE
6 TIE PLATE
7 RAKER
8 SWAY BRACE
9 JUNCTION-LINK BEARING
10 JUNCTION LINK

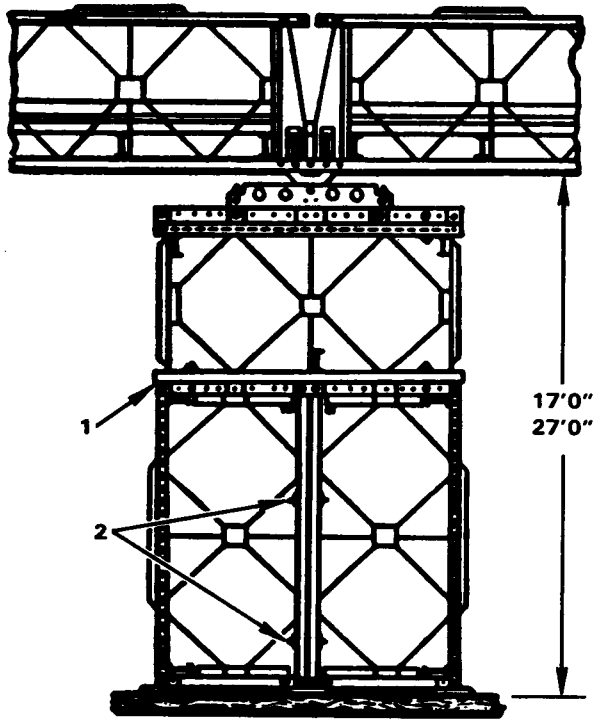
Figure 17-16 ***Single-story single-bay crib with panels horizontal***



1 SPAN JUNCTION POST

CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	50
ALL TRUSSES LOADED	100
TRIPLE TRUSS	145

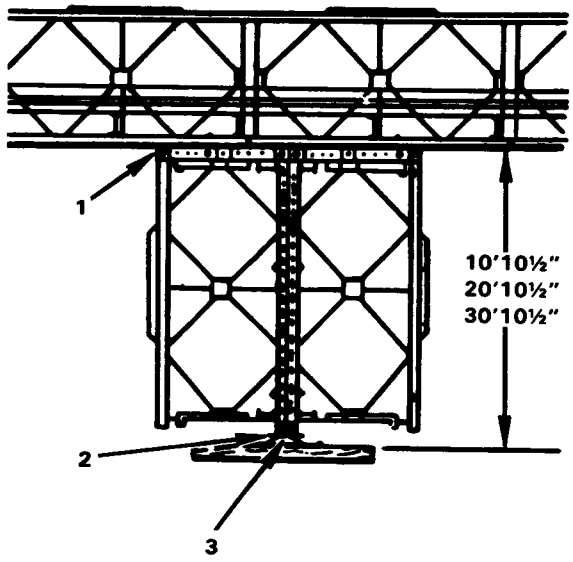
Figure 17-17 ***Single-story single-bay crib with panels horizontal;*** *bridge broken over crib*



1 MALE LUGS UPPERMOST
2 CHORD BOLTS

CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	50
ALL TRUSSES LOADED	100
TRIPLE TRUSS	145

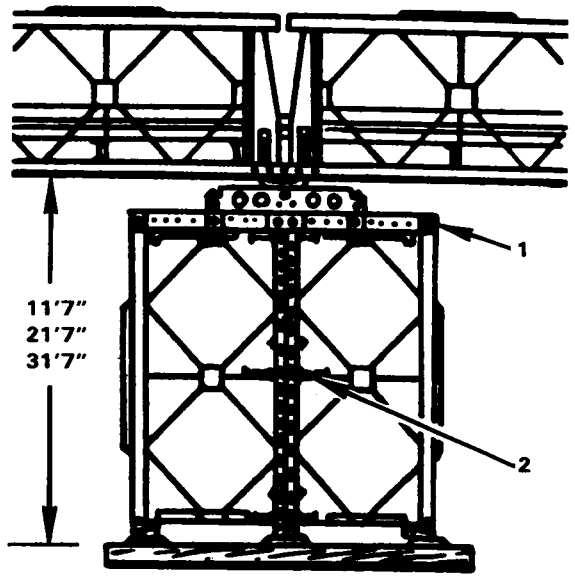
Figure 17-18 ***Bridge broken over double- to triple-story double-bay crib with panels both horizontal and vertical***



1 MALE LUGS UPPERMOST
2 CRIB BEARING
3 STANDARD BEARING

CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	45
ALL TRUSSES LOADED	90
TRIPLE TRUSS	130

Figure 17-19 ***Single- to triple-story double-bay with panels vertical;*** *continuous bridge with rocker bearing at base of crib*



1 MALE LUGS UPPERMOST
2 30-FOOT CRIB ONLY

CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	50
ALL TRUSSES LOADED	100
TRIPLE TRUSS	145

Figure 17-20 ***Single- to triple-story double-bay with panels vertical;*** *with bridge broken over crib*

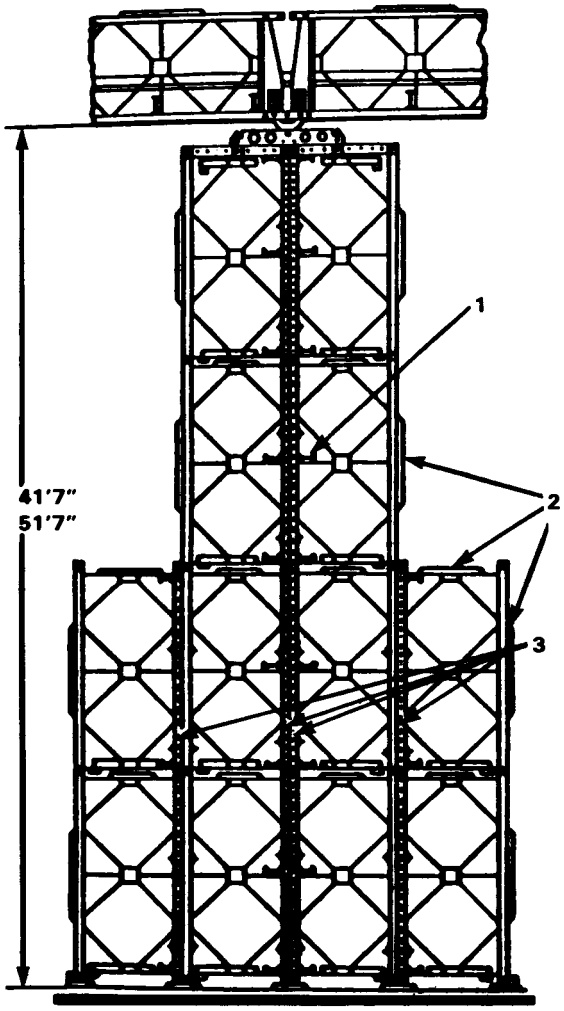


Table 17-3 ***Capacity of bridge pier assembled from basic bridge set***

CRIB PIER	BRIDGE CONTINUOUS OVER SUPPORT	BRIDGE BROKEN AT SUPPORT
DS (1H)	70	100
TS (1H)	90	145
DS (1V)	60	80
TS (1V)	60	80
DS (2V)	90	100
TS (2V)	130	145

1 TRANSOMS AT 5-FOOT INTERVALS FOR ALL CRIBS 30 FEET OR HIGHER
2 BRACING FRAMES
3 PLANES OF SWAY BRACING

CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	50
ALL TRUSSES LOADED	100
TRIPLE TRUSS	145

Figure 17-21 ***Four- to five-story crib with panels vertical;*** *with bridge broken over crib*

BILLS OF MATERIAL

Table A-15, Appendix A lists the number of parts required to build the standard crib piers illustrated in Figures 17-16 through 17-21, and the number of unit truck loads required to supply these parts. Panel-bridge conversion set No. 3, panel crib pier, supplies the special panel-crib parts to build a 31-foot 7-inch *triple-triple* pier with the addition of standard panel-bridge parts. The parts in conversion set No. 3 are listed in Table A-4, Appendix A. The conversion set No. 3 makes two crib-pier loads, each carried by a 5-ton dump truck. These truck loads are described in Chapter 2. The number of crib-pier loads and standard unit truck loads required to build each pier are given in Table A-15, Appendix A.

When using this table, note the following

- Plain bearings and base plates are not supplied in loads needed to build a pier. (Use extras from bridge construction.)
- Launching links Mk II are used for launching only. Remove them after bridge is in place.
- Panel pins listed do not include pins for launching links Mk II.

STANDARD ASSEMBLY OF TRUSSES AND BRACES

The trusses in standard panel crib piers are parallel to trusses in the bridge. The crib must have at least the same number of trusses as the bridge it is to carry. More

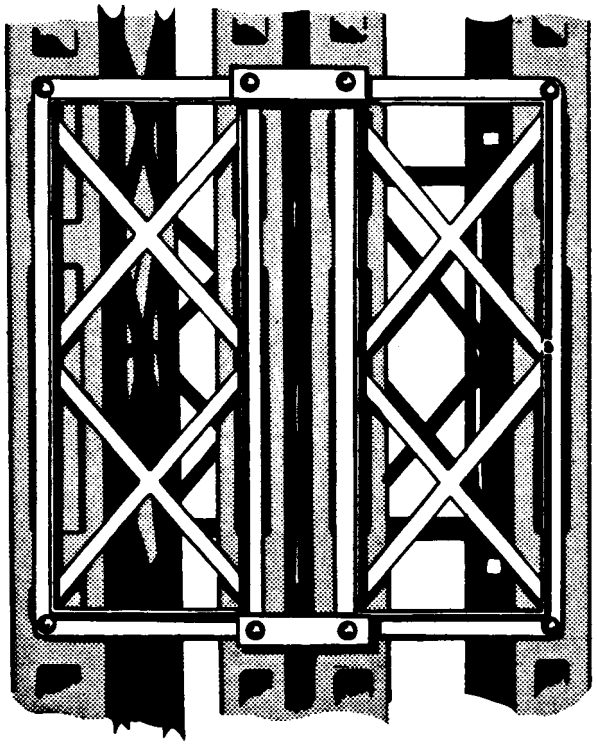


Figure 17-22 ***Close-up view of bracing in a quadruple-truss crib pier***

trusses can be added for increased strength (Figures 17-16 through 17-21). Single-truss assembly can be used only for low cribs carrying light loads. The number of bays in the pier will normally be enough to make the length of the base one third or more as much as the height of the pier (Figure 17-21). All possible bracing frames and tie plates tie trusses together at each side of the crib. In a quadruple-truss pier, bracing frames and tie plates overlap. Brace the entire crib by transoms and sway bracing (Figure 17-22).

In cribs with vertical panels, space transoms at 10-feet (3.1 meters) intervals in piers up to 30 feet (9.2 meters). In cribs only one bay long, invert panels of inner trusses with respect to panels in outer trusses so transoms can be attached to both chords. Sway bracing is on the same side of the crib throughout its height. In cribs with two bays of vertical panels, place panels so transoms and sway bracing are either at the center of the crib or at its sides. In cribs with four bays of vertical panels, add extra sway bracing in the outer bays (Figure 17-21).

In cribs with horizontal panels, half the panels may be right side up, and the other half inverted so transoms are at both top and bottom. Vertical-plane cross bracing may be provided by sway braces pinned to the sway-brace slot of the inverted second truss and fastened to the transom at the other end, or the sway bracing may be used as described later in this chapter.

In cribs under two-lane panel bridges, stagger transoms at the center panels (Figure 17-23). When panels are vertical, transoms in one half under one lane are all on top of panel verticals; in the other half, under panel verticals. At the top and bottom of the crib, transoms can be placed only on the side of panel verticals. Therefore, angles must be welded to the panel chords to take the place of alternate transoms (Figure 17-23, page 224). When the panels are horizontal, angles are also used to replace alternate transoms. Guy high piers to provide greater lateral stability.

BRIDGE SEATING

If the bridge is broken over the pier so the two spans act independently, use span junction posts, junction links, and junction-link bearings to seat it (Figure 17-5). If the crib is pivoted at its base so the bridge is fastened directly to the crib, slip chord clamps between the channels of the bridge chord and pin them to the crib capsill (Figure 17-16).

Figure 17-15 illustrates rocker bearings using panel-crib parts. This type of rocker bearing rests on abase plate on top of the pier. A wide platform on the top of the pier, to allow some leeway in positioning the baseplates, may be built from transoms and ramps welded in place (as described in the following paragraphs). An expedient rocker bearing may be made from one or two tranverse beams set on the top of the pier. The bearing must be under a panel vertical or the junction of panel diagonals. Figure 16-15 illustrates another expedient bearing.

CRIB BASE

There are several ways of setting panels onto a crib. With a fixed base, if panels in the first story of the pier are horizontal they may be set directly on a timber or masonry pier foundation (Figure 17-17). If panels in the first story are vertical, pin the female jaws of the panels to crib bearings which are set on timber or steel footings (Figure 17-20).

With a rocker base, the rocker may consist of a crib bearing seated on a standard bearing (Figures 17-15 and 17-16) or an inverted junction-link bearing set on an inverted junction link (Figure 17-16). The procedure is as follows:

- If panels in lower story of pier are horizontal, fasten crib capsill by chord clamps to bottom chord. Then pin this crib capsill directly to crib bearing (Figure 17-16), or by chord clamps to inverted junction-link bearing (Figure 17-16).
- If there is one bay of vertical panels with female ends down in the pier, connect female jaws by chord clamps to top of a junction-link bearing pinned to a crib bearing.
- If there are two bays of vertical panels, pin the two adjacent center female jaws to a crib bearing which is on a standard bearing (Figure 17-19).

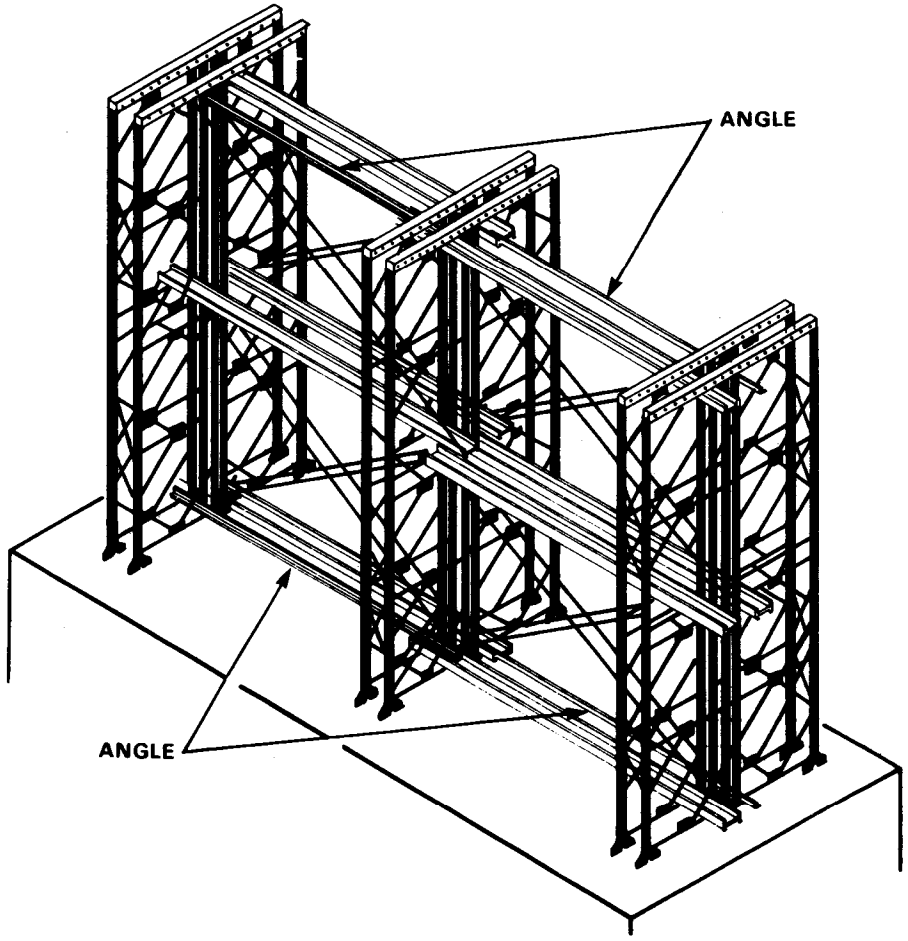


Figure 17-23 ***Standard assembly DD (2V-2V) panel crib pier for a DS-DD two-lane panel bridge***

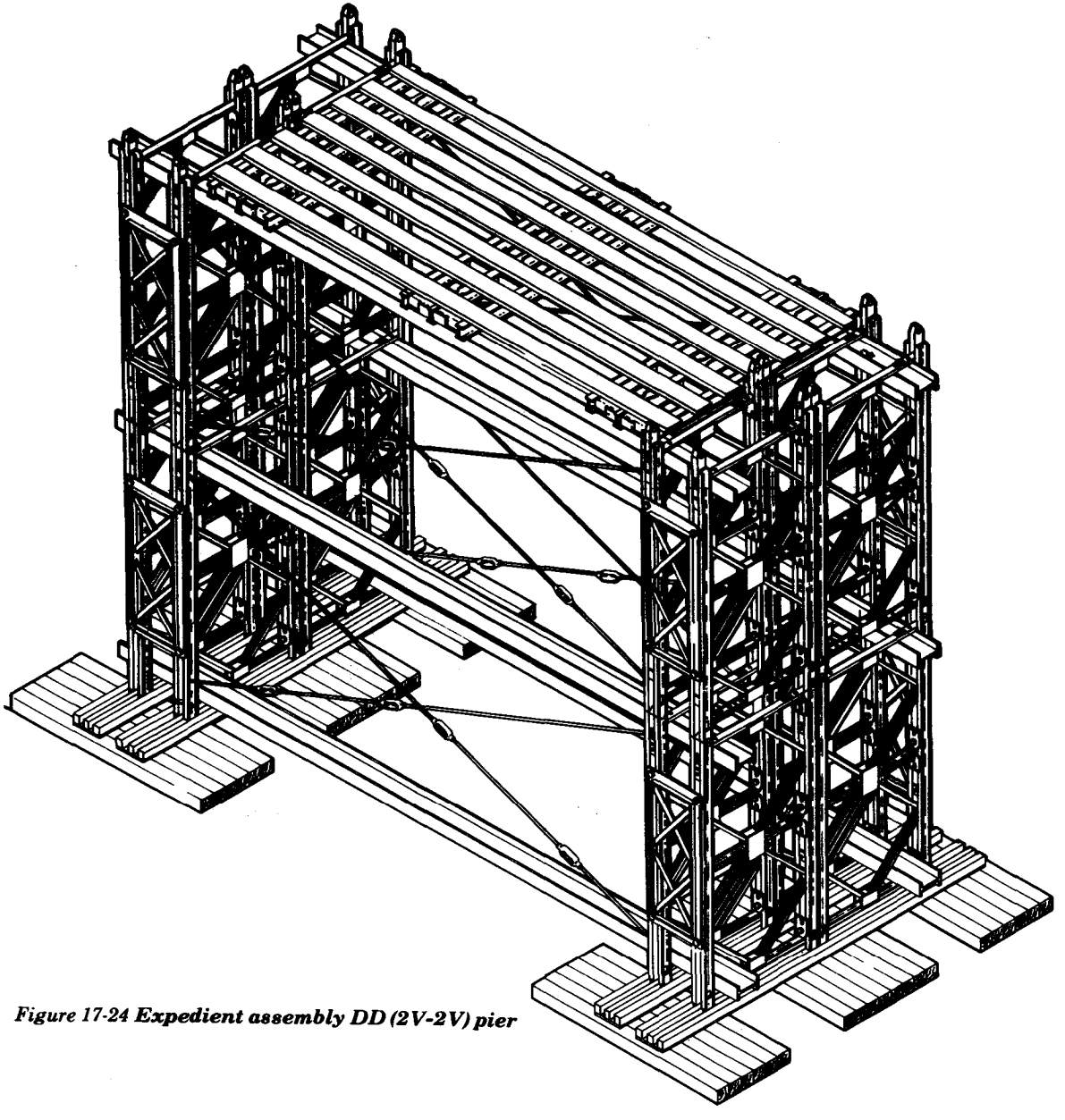


Figure 17-24 ***Expedient assembly DD (2V-2V) pier***

EXPEDIENT ASSEMBLY (STANDARD TRUSSES)

If no special panel-crib parts are available, the following expedient parts can be improvised for standard truss arrangement:

- Panel chords or any pair of 4-inch (10.2 centimeters) or larger channels with holes drilled at the desired spacing can be used for improvised crib capsills.
- Angles or lugs with pin holes in their upright parts can be fastened to the crib foundation and panels pinned to them. Another expedient is to have panel pins in female jaws of vertical panel bear on top of an I-beam or rail (Figure 17-24). A load of 7½ tons (6.8 metric tons) per panel pin is allowed on unstiffened beams having a web thickness of ¼ to $^{5}/_{16}$ inch (.6 to .8 centimeters). Greater loads are permitted if web is stiffened or if web thickness exceeds $^{3}/_{8}$ inch (.1 centimeter).
- Other special panel-crib parts are not readily improvised.

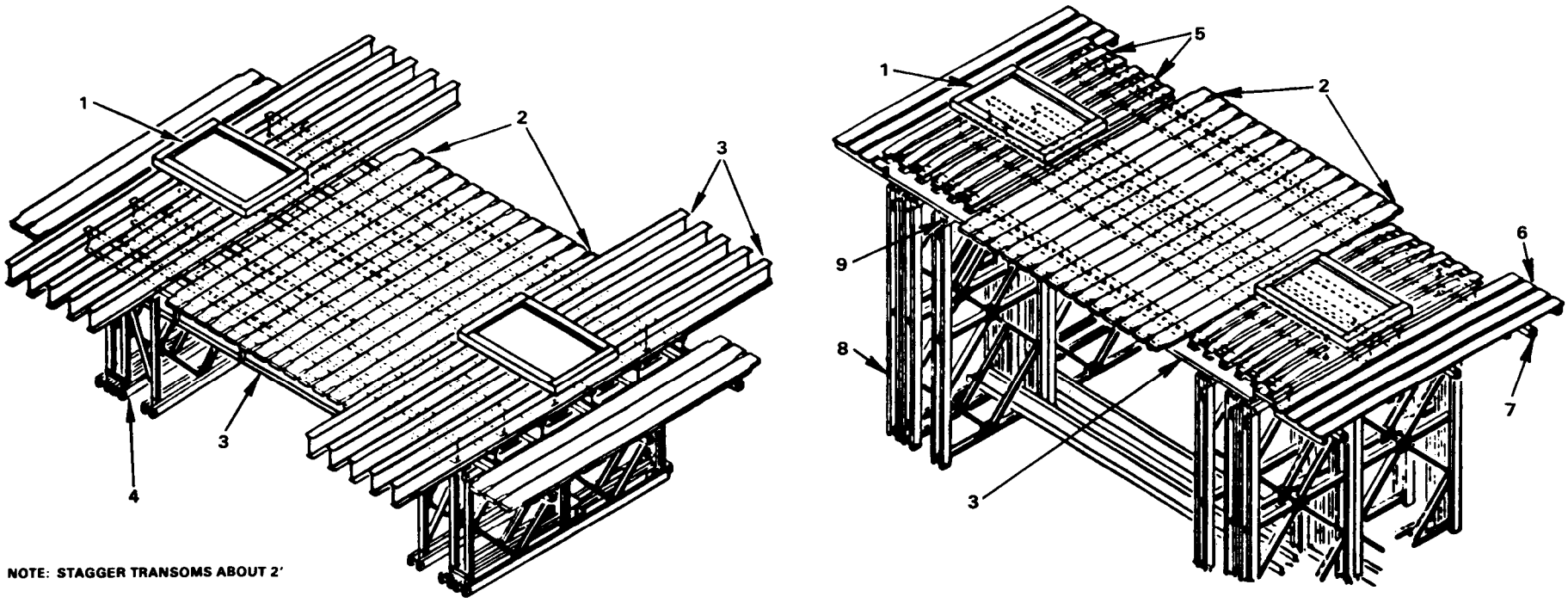


Figure 17-25 ***Expedient use of transoms and ramps to provide a flat top on the crib***

Bridge seating

Bridge seating assembly without panel-crib parts can be done as follows:

- Figure 17-25 shows the use of transoms and ramp sections to provide a flat top on the crib for the base plates under the rocker bearing. With this type of pier cap, the bridge may be as much as 6½ inches (16.5 centimeters) off the center of the pier. This is made up from a 4½-inch (11.5 centimeters) movement of the bearings on the base plate and a 2-inch (5.1 centimeters) movement of the baseplate on the pier top. Figure 17-26 (page 227) illustrates the vertical dimensions and capacities of piers with flat top and rocker ridge bearing.
- The bridge seating may consist of timber laid laterally on the end-panel member, but it is allowed a slight longitudinal movement.
- The pier can also be pinned to the bridge by pinning male lugs of the two inside posts of the pier to the lower bridge chord and inserting the outer posts in the space between channels of the lower chord. These outer posts just miss the center vertical in the bridge panels. If the outer

post shoulders are cut down enough to permit deflection in the span, this connection can be used with a rigid pier base. The top chord of the bridge is left unpinned so the two spans act independently.

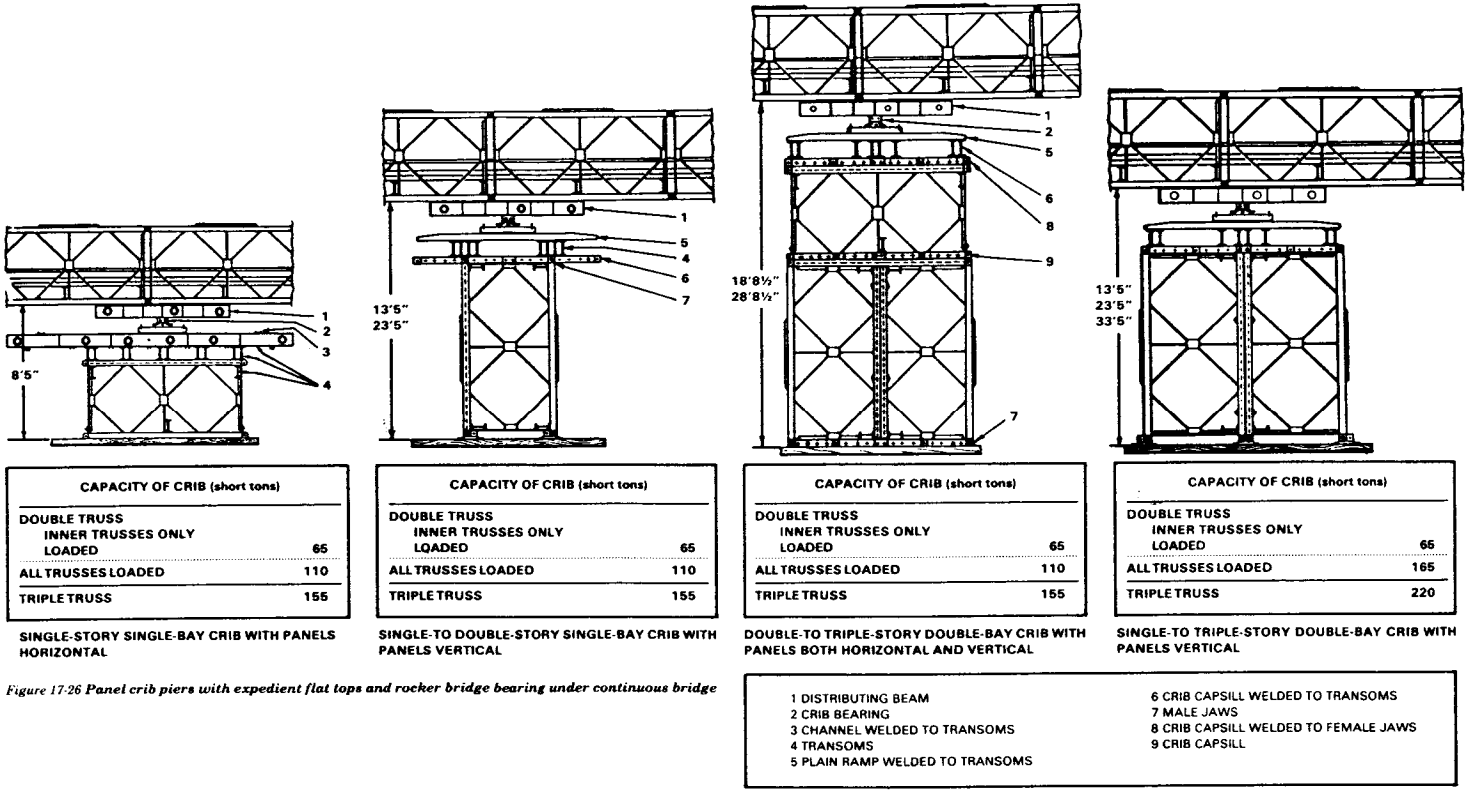
- Another method of bridge seating is to insert the male lugs of the pier posts into recesses in the lower bridge chords. Clamps made from two tie plates and ribband bolts anchor the bridge to the pier. This and the last two methods are limited because there is only one pier position in which the lugs fit without interfering with the bridge chord spacers.

Crib base

To make a crib base without special panel-crib parts, set the crib on timber and have the cribbing bear on the bottom panel member.

Panel connections

To connect horizontal and vertical panels, cut away the reinforcing plate at the bracing-bolt hole and slip the male lugs of the vertical panel between the channels of the horizontal chord. Tie panels together by an expedient clamp made from tie plates and ribband bolts (Figure 17-27, page 228).



CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	65
ALL TRUSSES LOADED	110
TRIPLE TRUSS	155

SINGLE-STORY SINGLE-BAY CRIB WITH PANELS HORIZONTAL

CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	65
ALL TRUSSES LOADED	110
TRIPLE TRUSS	155

SINGLE-TO DOUBLE-STORY SINGLE-BAY CRIB WITH PANELS VERTICAL

CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	65
ALL TRUSSES LOADED	110
TRIPLE TRUSS	155

DOUBLE-TO TRIPLE-STORY DOUBLE-BAY CRIB WITH PANELS BOTH HORIZONTAL AND VERTICAL

CAPACITY OF CRIB (short tons)	
DOUBLE TRUSS INNER TRUSSES ONLY LOADED	65
ALL TRUSSES LOADED	165
TRIPLE TRUSS	220

SINGLE-TO TRIPLE-STORY DOUBLE-BAY CRIB WITH PANELS VERTICAL

1 DISTRIBUTING BEAM
2 CRIB BEARING
3 CHANNEL WELDED TO TRANSOMS
4 TRANSOMS
5 PLAIN RAMP WELDED TO TRANSOMS
6 CRIB CAPSILL WELDED TO TRANSOMS
7 MALE JAWS
8 CRIB CAPSILL WELDED TO FEMALE JAWS
9 CRIB CAPSILL

Figure 17-26 Panel crib piers with expedient flat tops and rocker bridge bearing under continuous bridge

EXPEDIENT ASSEMBLY (NONSTANDARD TRUSSES)

Expedient assembly of trusses and bracing can also be built for nonstandard truss arrangements.

Trusses

Expedient panel cribs can be built with panels transverse to the bridge axis, as in Figure 17-28. This type of construction is useful when the pier is skewed or when the pier foundations are restricted. Two panels pinned end to end give a 20-foot (6.2 centimeters) pier width. In Figure 17--28 trusses are braced together by bracing frames in every possible position, Bracing frames are overlapped at each end and 5-inch- (12.7 centimeters) long bolts replace standard bracing bolts. In lighter one-story piers, the two panels are connected by tie plates.

The crib may be built in the form of two cellular columns, one under each side of the bridge, as in Figure 17-29 (page 230). Each column is made of four vertical panels arranged in a square offset 45 degrees from the axis of the bridge. Weld chords of adjacent panels to angles. Cap panels with improvised capsills, and lay timber cribbing across capsills. The crib base is similarly constructed. Tie the two columns together by tie reds welded between them.

Bracing

More than one story of horizontal panels can be used if more expedient vertical cross bracing is added. Figure 17-30 (page 231) shows sway braces in the vertical plane bracing a double-story pier to carry light loads. Bolt tie plates to one end of the sway braces on an extension. Bolt lengthened sway braces diagonally between the lower bracing, frame hole in the end vertical of one truss and the upper bracing frame hole of the end vertical on the opposite truss. As an alternative, vertical sway braces can be used in each story.

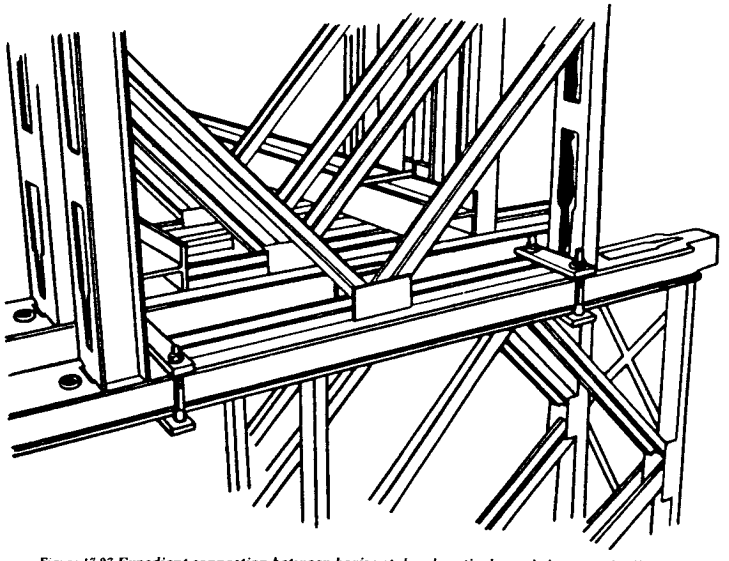


Figure 17-27 Expedient connection between horizontal and vertical panels in a panel crib pier

Pin the braces to the bottom chord of the second panel, bend them up, and weld them to the underside of the top chord in the opposite inner truss (Figure 17-31, page 231).

For heavier loads, channel sections welded across each end of the crib give a more rigid cross brace (Figure 17-31).

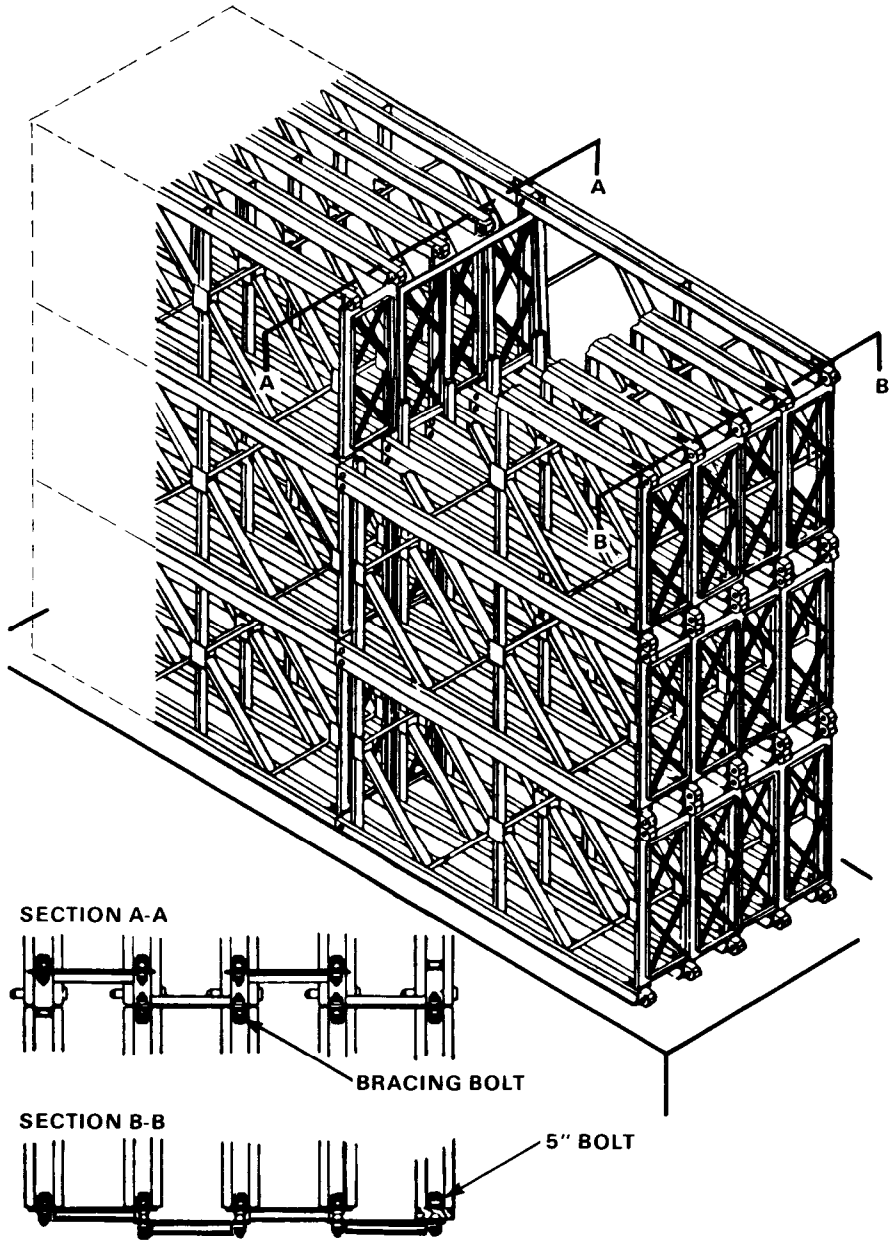


Figure 17-28 ***Expedient panel crib pier with panels transverse to axis of bridge***

ASSEMBLY OF CRIB PIER

Use the following sequence of procedures when building crib piers by manpower alone:

1 Lay out and accurately level pier foundation. Mark panel positions accurately. Position crib bearings where these are used.

2 Carry up panels for trusses on each side of crib and lay flat on base with female jaws pointing to bearings. Lift up panels and pin to bearings.

3 Fasten transoms, rakers, bracing frames, and sway braces in the first story. Check that panels are vertical and square to the centerline.

4 Construct a working platform of transoms and chess in the first story. Haul panels up singly and lay them flat on the platform with the female jaws opposite the top lugs of the first story. Lift each panel in turn and pin it into position.

5 Fasten transoms and bracing in the second story and again check that the crib is vertical and square to the centerline.

6 Repeat for the number of stories required. An improvised gin pole or davit may be used to lift panels and transoms to upper stones.

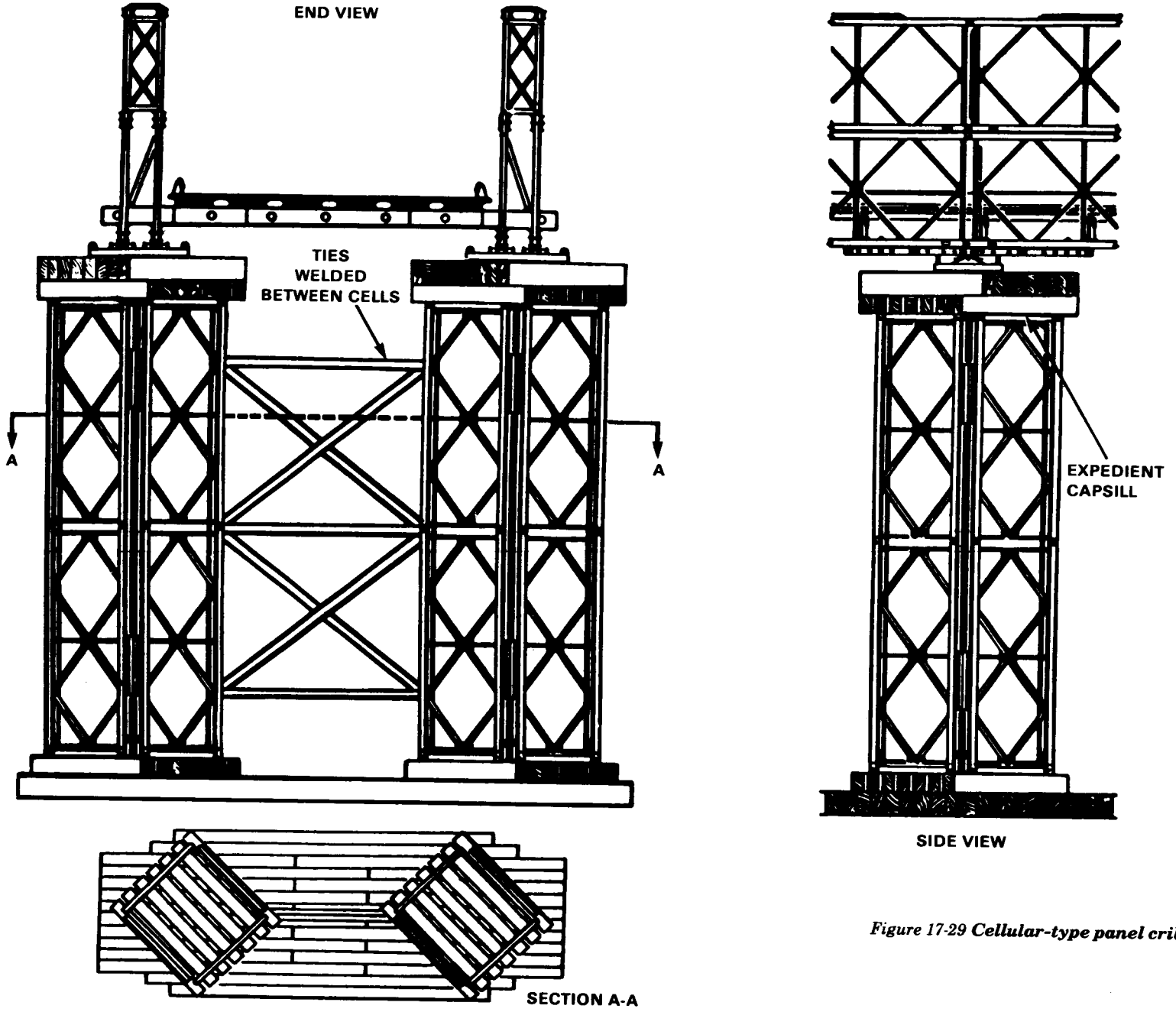
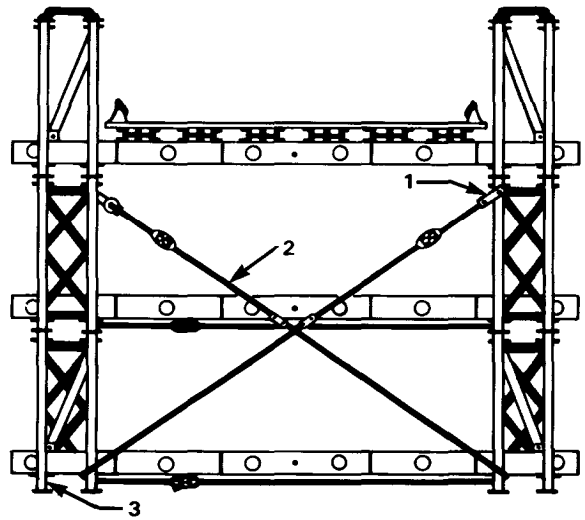
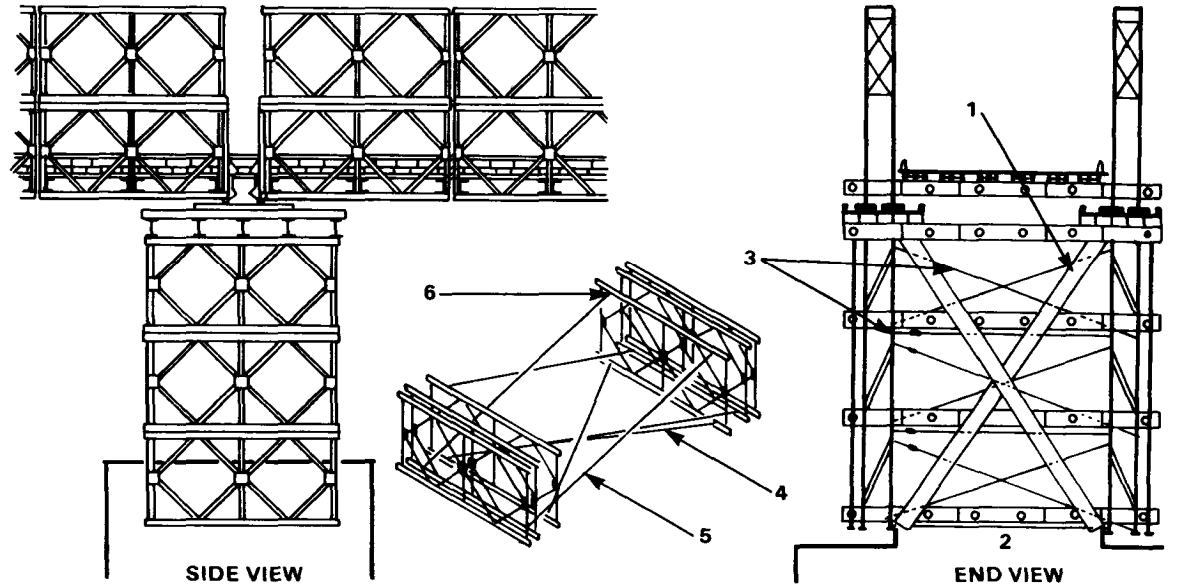


Figure 17-29 ***Cellular-type panel crib pier***



1 TIE-PLATE EXTENSION TO SWAY BRACE
2 SWAY BRACE IN VERTICAL PLANE
3 HORIZONTAL PANELS

Figure 17-30 ***Sway-brace cross bracing in two-story panel crib pier***



1 CHANNEL CROSS BRACING
2 BASE OF PIER SET IN CONCRETE
3 SWAY BRACES
4 NORMAL SWAY BRACING
5 SWAY BRACE IN VERTICAL PLANE
6 WELD VERTICAL SWAY BRACE TO UNDERSIDE OF CHORD

Figure 17-31 ***Expedient cross bracing in three-story panel crib pier***

Use the following procedures when building piers with mechanical equipment:

- If site conditions permit, a truck-mounted crane can be used to erect 20-foot- (6.2 meters) high crib piers and the two lower stories of high piers. Assemble bays on the ground nearby, and lift the assembly into place by crane. For erecting higher piers, use a long-boomed crane.
- If pier construction is between existing high banks or piers, use cranes and high lines with winches on banks or existing piers to lift panels into place.
- If the bridge without the pier will carry the erection equipment, the pier can be constructed from the bridge. Use a truck crane or rope tackle to lower the panel over the side of the bridge into place on the pier. When all panels in the pier are in place, jack up the bridge over the pier to eliminate sag and allow placing of bridge seating. This last step can be eliminated by leaving the bridge on rollers at each abutment until after the pier is completed. Rollers must be blocked up enough to keep the bottom chord above the level of the top of the finished pier.
- For a continuous-span bridge, the pier can be built by working from the end of a cantilever span.

LAUNCHING OF BRIDGE

Place rocking rollers on cribbing on top of the piers before launching the bridge (Figure 17-32). Push the bridge out over these rollers until the entire bridge is over all the spans. Jack up the bridge, remove rollers and cribbing, and then jack down the bridge onto its seatings on piers (Figure 17-33). A temporary working platform may have to be built for operating the jacks (Figure 17-34, page 234). If the bridge is to have independent spans, disconnect the girders at each pier.

JACKING DOWN OF CONTINUOUS SPANS

Where the distance through which the bridge has to be raised or lowered is more than a few inches, jacking has to take place on more than one pier at the same time. Since in this type of construction the whole girder is continuous, lifting through any distance progressively increases the length of bridge lifted and, thereby, increases the weight to be raised. This soon exceeds the capabilities of the jacks that can be brought into use on one pier. Where these conditions apply, a sequence of jacking on three piers at the same time, as described below, is the easiest method. This consists of raising the bridge through a smaller distance on each of the piers adjacent to the one on which the distributing beams are being fitted.

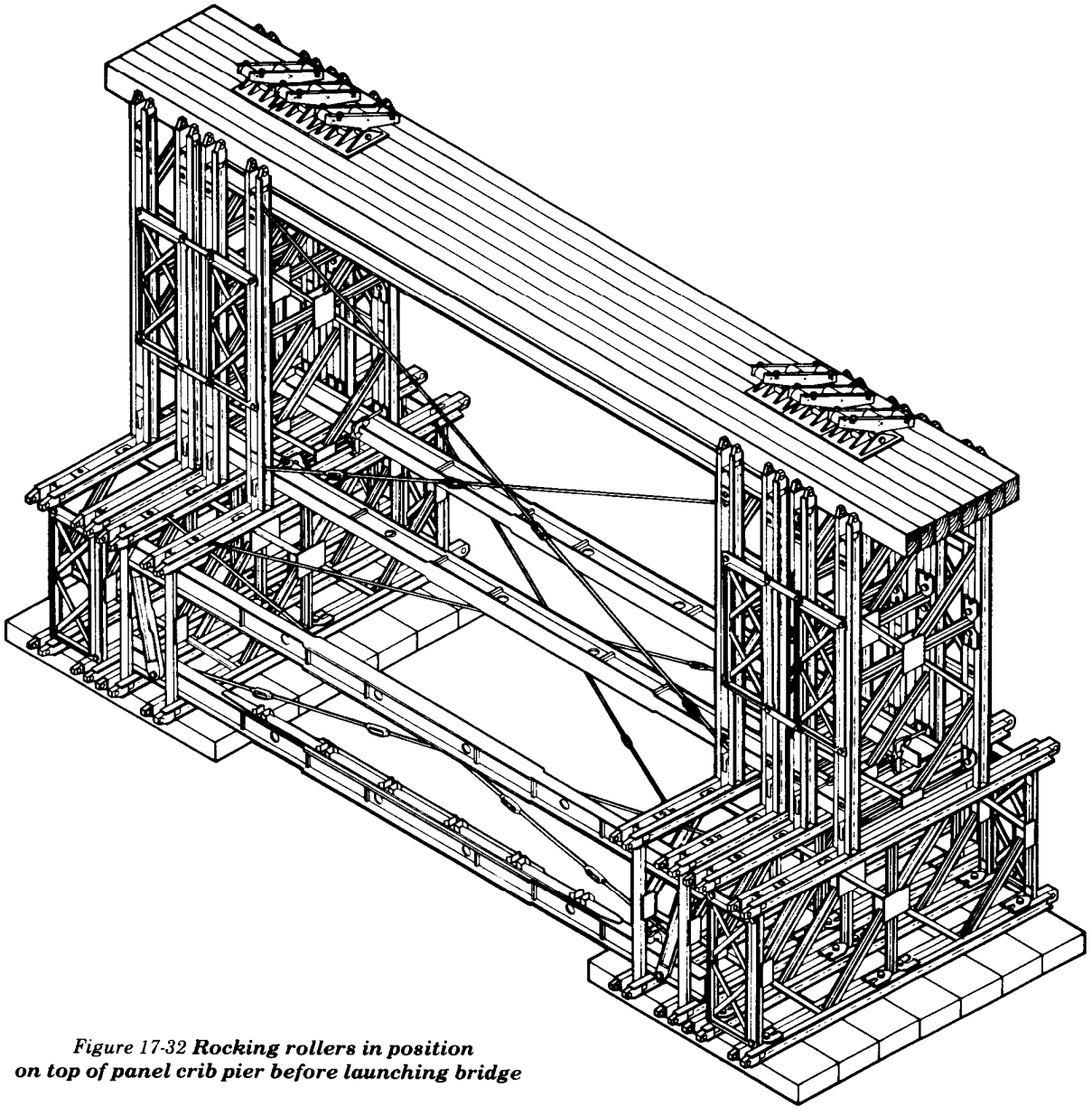


Figure 17-32 ***Rocking rollers in position on top of panel crib pier before launching bridge***

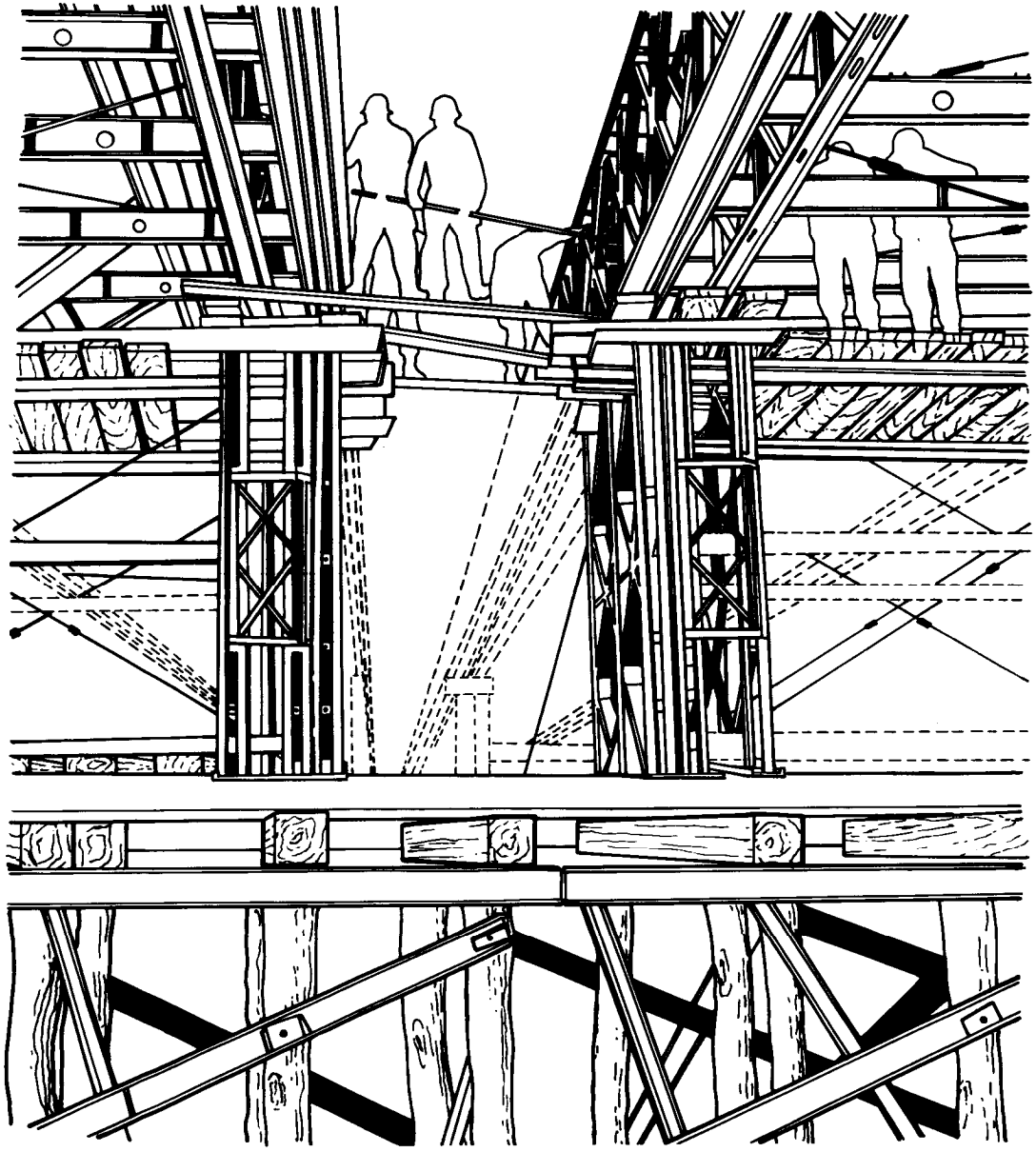


Figure 17-33 ***Two panel bridges being jacked down onto panel crib piers***

The ends of the bridge are first jacked up and lowered onto suitable cribbing slightly above final level. Three complete jacking parties are then required for the intermediate piers, working from the near bank and in the following steps:

1 The first party, working on the first pier, lifts the bridge clear, removes the rollers and lowers the bridge onto the cribbing, the height of cribbing being the same as that used at the end of the bridge.

2 The second party does the same on the second pier while the first party jacks up on the first pier, fits distributing beams, and lowers the bridge to the original level (level of top of cribbing).

3 The third party completes step 1 on the third pier and the second party then fits distributing beams on the second pier. The first party then lowers the bridge onto the bearings of the first pier.

4 The first party completes step 1 on the fourth pier, the third party then fits distributing beams on the third pier, after which the second party lowers the bridge onto the bearings on the second pier.

This sequence of steps is continued throughout the length of the bridge. By this means, the bridge is raised by a slightly smaller amount on the two piers adjacent to the one on which the distributing beams are being fitted. Strict control of the jacking parties is essential, however, to enable the distributing beams to be fitted on the center pier.

In the case of long bridges, it may be expedient to begin jacking on the center pier and work outwards toward the ends of the bridge. For this method, it is best to employ six jacking parties, three working toward each bank in the sequence of steps described above.

Where the distance through which the bridge has to be lowered is such that it cannot be achieved in three stages, increase the number of jacking parties.

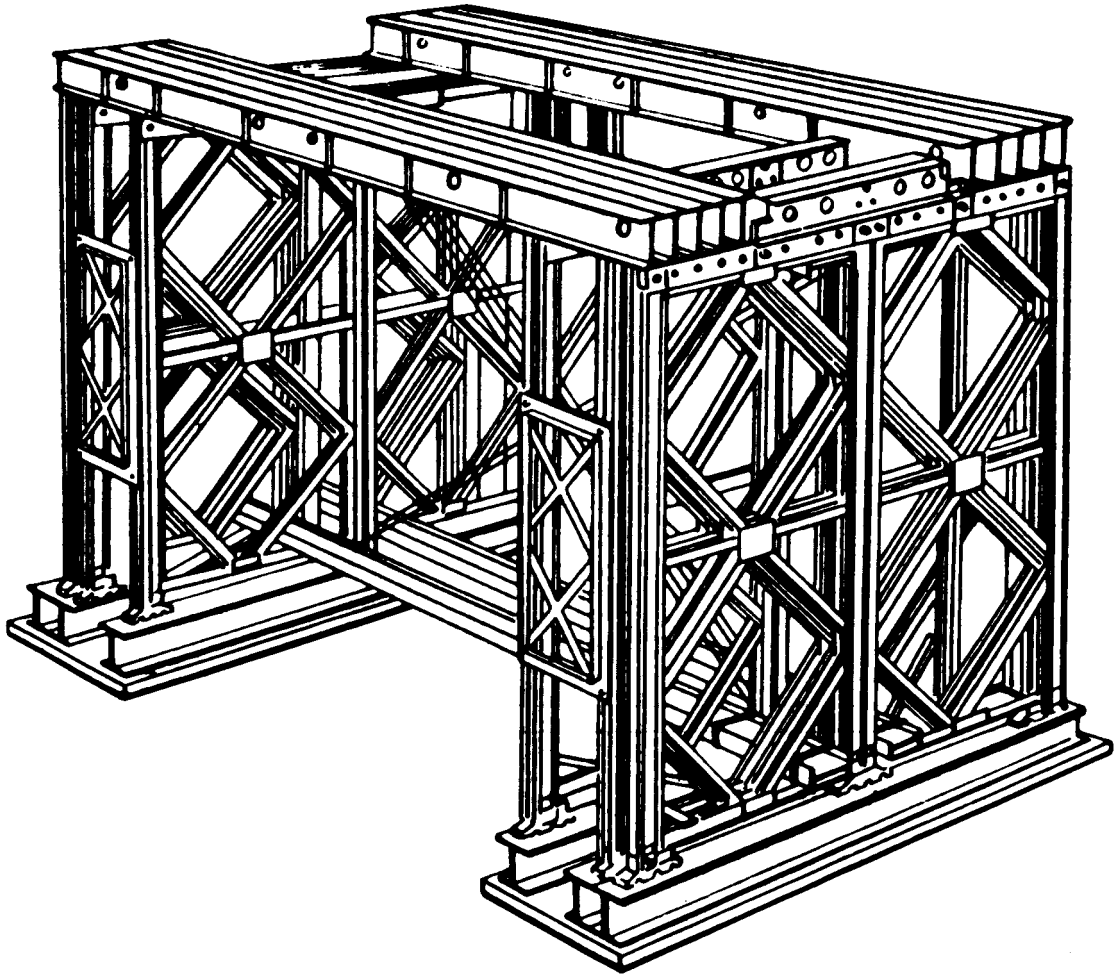


Figure 17-34 ***Temporary working platform made of transoms***

CHAPTER 18

SPECIAL LAUNCHING METHODS

Special launching methods are needed when a restricted site prevents normal roller layout and launching by the standard skeleton launching-nose method. Space on either bank may be restricted in length or width by obstructions such as buildings, existing bridge girders, trees, and earthwork or by sloping banks and canal dikes. Limited backspace or length of assembly area on the near bank is the most common restriction. Backspace is measured from the near-bank rocking rollers to the limiting obstruction. Far-bank conditions are a less common restriction because standard launching tables allow progressive dismantling of all launching noses and this requires a minimum clear distance of only 12 feet (3.7 meters) beyond the far-bank rollers. Several methods included in this chapter, however, reduce far-bank requirements even more by landing directly on bearings and by inverting the nose assembly to clear low obstructions such as existing girders.

USE OF COUNTERWEIGHTS

Restricted sites require the launching of Bailey bridges using fixed and movable counterweights. These can be used with standard launching-nose assembly for a site with limited backspace on the near bank. Several bridge bays are omitted during launching. Counterbalance of the span is maintained by placing a counterweight in the last bridge bay equivalent to the missing bays.

These counterweights can also be used with launching-tail assembly for sites with far-bank limitations preventing use of launching nose or far-bank rollers. Use counterweight tail instead of standard skeleton nose to keep balance point behind near-bank rocking rollers during launching. Launch bridge with end posts mounted on leading end and land it directly on far-bank bearings.

Types of counterweights

Any available material of known weight, such as spare bridge parts, sandbags, or vehicles can be used as a fixed counterweight. Add this counterweight to the end bay of the bridge or tail just before final launching to the far bank. When launching with a movable counterweight, add it earlier in the bridge assembly and roll it back onto successive end bays to counterbalance progressive launching stages. The two types of rolling counterweights are vehicles and rolling platforms. Trucks, trailers, tanks, tractors, and bulldozers mounted on the bridge deck are pushed, or moved back under their own power, as assembly progresses. Vehicles can be loaded to weights shown in launching tables or shifted slightly in position on the deck of the end bay to provide correct counterbalance. Backspace is often increased by requirements for ramps and space to maneuver and mount the vehicle on the deck.

Figure 18-1 (page 236) shows two movable platforms rolling on inverted plain rollers. Add more counterweight in the form of spare bridge parts, sandbags, or any available material of known weight. Platforms can be used singly or together with either a skeleton launching nose or launching tail. Special details in assembly and launching are as follows:

- Four plain rollers are required for all lower platforms and for all upper platforms on *single-single* bridges. Upper platforms on double-and triple-truss bridges require eight rollers. In triple-truss assembly, upper-platform rollers must not bear on the outer trusses. Rollers need not be fastened to the stringer framework.
- Platforms are moved by block and tackle on both trusses.
- Horizontal bracing frames on the top bridge chord are added after the bays have passed under upper platform rollers.

Backspace and limitations

Table 18-1 (page 236) shows the backspace required to launch fixed-panel bridges by the standard launching-nose method without the use of counterweights. The center of gravity or balance point of the bridge is always kept at least 2 feet (61.1 centimeters) behind the near-bank rocking rollers. Distances in the table include 12 feet (3.73 meters) to add the last bay of bridge or tail. All backspaces

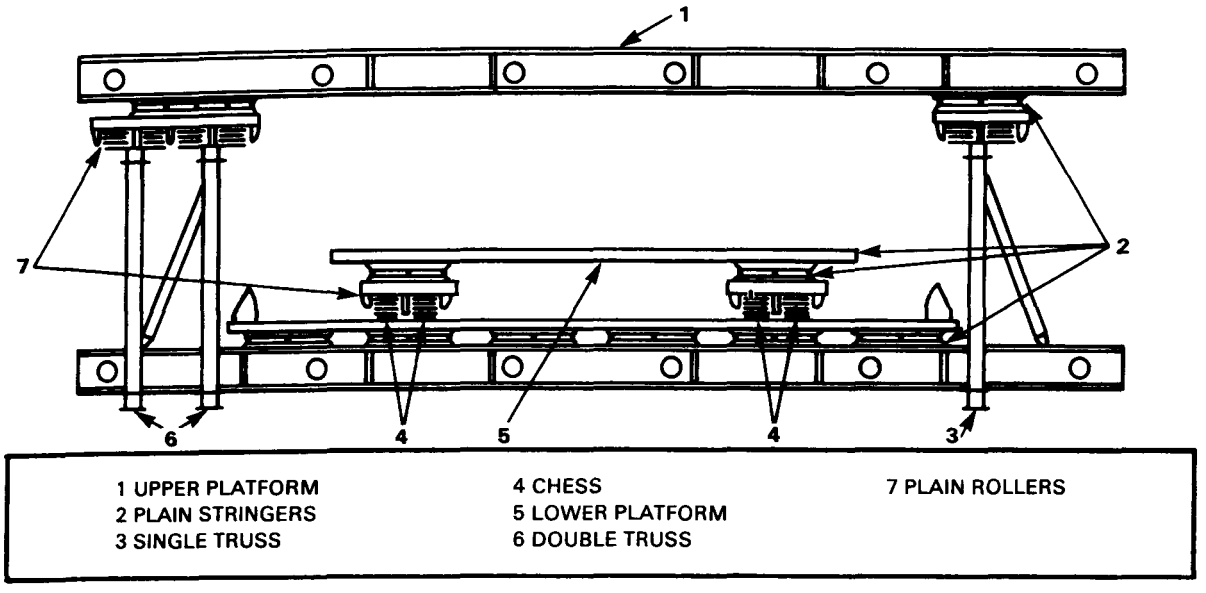


Figure 18-1 ***Rolling platform counterweights***

include 2 feet between the center of gravity of the bridge and near-bank rocking rollers and 12 feet to build the last bay of the bridge or tail.

All counterweight methods increase launching weights. Maximum spans launched by these methods are therefore shorter than those launched by the standard launching-nose method because of the resulting increase in combined stress in the lower chord over the launching rollers.

LAUNCHING NOSE AND COUNTERWEIGHT (ROLLING)

The length of launching nose, composition of nose and bridge bays, and organization of working parties are the same as in standard-launching method (Chapter 6). However, use of a counterweight instead of end bays as counterbalance for cantilever launch to far bank requires several changes. On *double-single* assembly, use plain rollers in pairs (one under each truss) instead of singly as in the standard method. All launching noses can be moved forward from 12 to 17 feet, after the assembly of the first bridge bay, to allow mounting of rolling counterweight on deck. If more space is needed, add temporary fixed counterweight to the bridge or adjacent nose bay and launch nose further over gap. Assemble all bridge bays complete for final launch to far-bank rollers except for *triple-single* and *double-double* bridges, which are

Table 18-1 ***Backspace in feet required to launch fixed panel bridges by the standard launching-nose method***

TYPE OF CONSTRUCTION	SPAN (ft)	BACKSPACE (ft)
	30	35
	40	43
	50	47
	60	55
	70	63
	80	67
	90	75
	50	45
	60	52
	70	57
	80	64
	90	71
	100	76
	110	83
	120	90
	130	95
	80	63
	90	70
	100	74
	110	81
	120	86
	130	93
	140	100
	100	74
	110	81
	120	86
	130	93
	140	100
	150	106

double-single assembly in end bay. To speed assembly after landing on far bank, add remaining bridge bays, complete launch, and remove nose. Install far-bank end posts, jack down, and install ramps. Move rolling counterweight to far-bank end of bridge, install near-bank end posts, and jack down. Position near-bank ramps and remove counterweights.

Table 18-2 ***Assembly for launching with*** *standard launching-nose counterweight*

TYPE OF CONSTRUCTION	SPAN* (ft)	BAYS OF BRIDGE	LAUNCHING CONSTRUCTION BAYS OF NOSE SS	LAUNCHING CONSTRUCTION BAYS OF NOSE DS	BACK SPACE (ft) FIXED COUNTER-WEIGHT	BACK SPACE (ft) ROLLING COUNTER-WEIGHT	COUNTER-WEIGHT (tons) 5 FEET FROM END OF BRIDGE	LAUNCHING WEIGHT (tons)	SAG (in)
SS	30	2	2		28	26	3.1	11.0	2
	40	2	3		31	31	7.7	16.5	3
	50	4	3		37	32	4.2	18.5	4
	60	4	4		41	36	7.3	23.0	7
	70	5	5		48	42	4.2	23.5	10
	80	6	5		53	42	8.3	30.5	13
	90	6	6		56	46	11.4	34.5	20
DS	50	4	3		36	32	3.8	21.0	3
	60	4	4		39	36	7.0	25.0	5
	70	5	4		43	36	13.7	35.0	7
	80	6	5		51	43	8.0	34.0	12
	90	6	6		54	46	11.0	38.0	17
	100	7	6		58	46	15.0	45.5	20
	110	8	7		65	51	15.7	50.5	28
	120	8	8		68	56	15.0	50.5	38
	130	10	8		77	63	13.2	55.5	45
TS	80	6	5		50	42	8.3	37.0	11
	90	6	6		53	46	11.3	41.0	17
	100	7	6		57	46	18.3	52.0	20
	110	8	7		64	52	12.3	51.1	26
	120	9	7		69	53	18.7	61.5	30
	130	10	8		76	62	13.5	61.5	42
	140	10	9		78	62	16.3	65.0	57
DD	100	8	6		61	52	9.7	52.1	15
	110	8	7		65	54	12.5	54.0	19
	120	9	7		67	52	19.6	68.0	22
	130	10	8		74	62	13.7	67.4	29
	140	10	7	2	77	62	18.1	74.1	36
	150	12	6	3	87	72	17.5	83.4	38

*Launching spans 5 feet less than bridge spans

Table 18-2 gives assembly for all bridges that can be launched with an appreciable reduction in backspace over the standard method using either fixed or rolling counterweights of the amount shown. Data are based on the following assumptions:

- All counterweight is centered in end bay of bridge.
- Minimum backspace for any bridge is that required to assemble the launching nose and first bay of bridge without counterweight.
- Length of bridge for launching with rolling counterweight of amount shown in Table 18-2 requires about the same backspace as required to assemble nose and first bay.
- All bridge bays are decked and complete at critical launching stage except that end bays of *triple-single* and *double-double* bridges are *double-single* construction. Bridges are launched without footwalks.
- Fixed counterweight is added to end bay for final launching only.
- Rolling counterweight is added on first bridge bays and rolled back onto successive end bays.

LAUNCHING TAIL AND COUNTERWEIGHT (FIXED)

The launching-tail method differs from the standard nose and counterweight method in several ways. The tail is of exactly the same assembly as bridge bays (Figure 18-2). All bridges are launched without deck and stringers, except the end bay of the tail when using fixed counterweight. End posts mounted on leading end of the bridge and landing directly on bearings eliminate rollers and jacking down on far bank. The length of bridge required is 2 feet 6 inches (76.4 centimeters) longer than launching span or gap, instead of 5 feet (1.5 meters) as for the launching-nose method (Figure 18-2). Since there is no nose into which launching links can be inserted, allow for sag made by difference in elevation between near-bank rocking rollers and far-bank bearings, unless site conditions allow cantilever end of a manually launched bridge to be raised by bearing down on tail at end posts near bearings.

Table 18-3 gives necessary data for launching with tail and counterweight. Tails shown are of minimum allowable length to maintain chord stresses over rocking rollers within allowable limits. Where the site permits the use of longer tails, corresponding lighter counterweights can be calculated by taking moments about the near-bank rocking rollers. When using rolling counterweight (upper platform, Figure 18-1), values shown in the table must be increased 1.5 tons (1.4 metric tons) in place of end-bay deck and stringers.

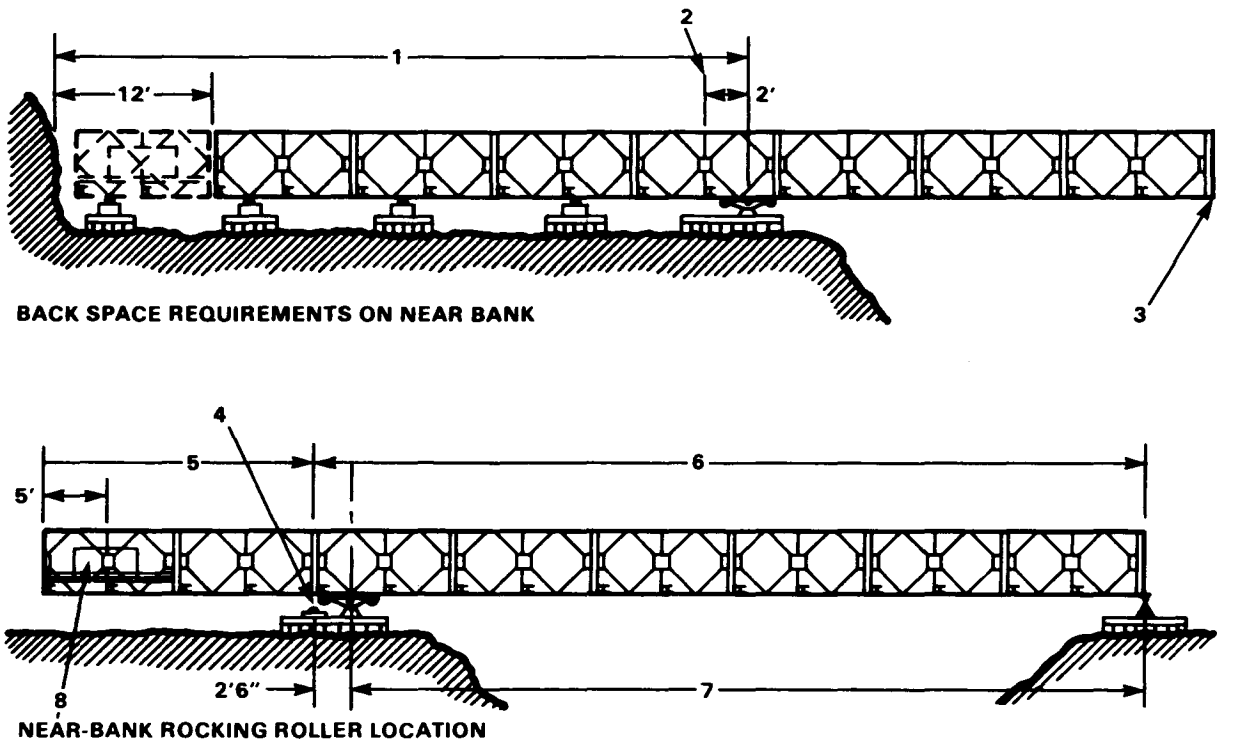


*Figure 18-2 **Site layout for launching with tail and counterweight***

Data in Table 18-3 are based on the following assumptions:

- The bridge is launched without footwalks, deck, and stringers, but with far-bank end posts.
- Tail construction is same as bridge.
- Counterweight is 5 feet from end of bridge.
- Sags are approximate (add 6 inches for end-post projection).
- Two bays of the second story are omitted at leading end of bridge.

*Table 18-3 **Assembly for launching with** tail **and** counterweight*

TYPE OF CONSTRUCTION	SPAN* (ft)	BACKSPACE (ft) FIXED CW	BACKSPACE (ft) ROLLING CW	TAIL LENGTH (bays)	TAIL COUNTERWEIGHT (tons)	LAUNCHING WEIGHT (tons)	SAG (in)
SS	30	30	24	1	5.0	12.5	1
	40	35	24	1	11.0	19.5	2
	50	40	24	1	18.5	28.5	3
	60	50	33	2	10.0	22.5	5
	70	55	33	2	15.0	29.0	8
	80	60	34	2	20.5	35.5	12
	90	70	43	3	15.5	33.0	18
DS	50	41	26	1	28.0	42.0	3
	60	51	33	2	15.0	32.5	5
	70	56	33	2	22.5	42.0	7
	80	61	34	2	30.5	52.0	10
	90	66	34	2	40.0	63.5	15
	100	75	43	3	29.5	57.0	21
	110	85	53	4	24.5	56.0	27
TS	80	68	43	3	22.5	52.5	11
	90	73	43	3	31.0	64.0	16
	100	83	53	4	25.5	63.5	20
	110	93	63	5	23.0	66.0	26
DD	100	80	52	4	33.0	80.0	12
	110	85	52	4	41.5	91.5	16
	120	86	53	4	43.5	94.5	18
	130	87	53	4	44.5	95.0	20

*Launching spans 2 feet 6 inches less than bridge spans

- Five bays of the second story are omitted at leading end of bridge.

INVERTED LAUNCHING NOSE

Far-bank sites with low obstructions and limited clearance widths, such as low sidewalls or existing girders on narrow piers, which interfere with launching-nose transoms, can often be cleared with inverted launching noses. Assembly is the same as in standard launching tables except that nose panels are inverted and transoms, rakers, and sway braces are in the upper instead of the lower chord. Vertical clearance beneath transoms is increased 3 feet 6 inches (1.1 meters). Launching links are placed in the lower chord as in the standard nose.

LAUNCHING PLATFORMS

When a launching site is sharply sloped, launching platforms may be built as follows:

- In launching from sloping banks or over canal dikes (Figure 18-3, page 240), rollers can be supported on panel crib piers (Chapter 17) to provide a level launching site.
- Panel bridges can be assembled in place or launched without nose or tail over continuous timber or panel falsework or cribs 25 feet (7.6 meters) on centers across the gap. With rollers spaced 25 feet (7.6 meters) apart, sag requires jacking of leading end as it reaches roller position. For a double-single bridge, the sag of the leading end will be 2 to 3 inches (5.1 to 7.6 centimeters) with a 25-foot (7.6 meters) overhang.

END-ON ASSEMBLY

End-on assembly of a panel bridge is the successive addition of bays on the cantilever end over the gap. Use no rollers. Support the bridge during assembly on a packing of timber and transoms under the bottom chord. Provide counterbalance either by the simultaneous addition of tail of the same length and assembly as the bridge or by a shorter tail and heavy counterweight. Position panels with improvised davits and rope tackle or cranes.

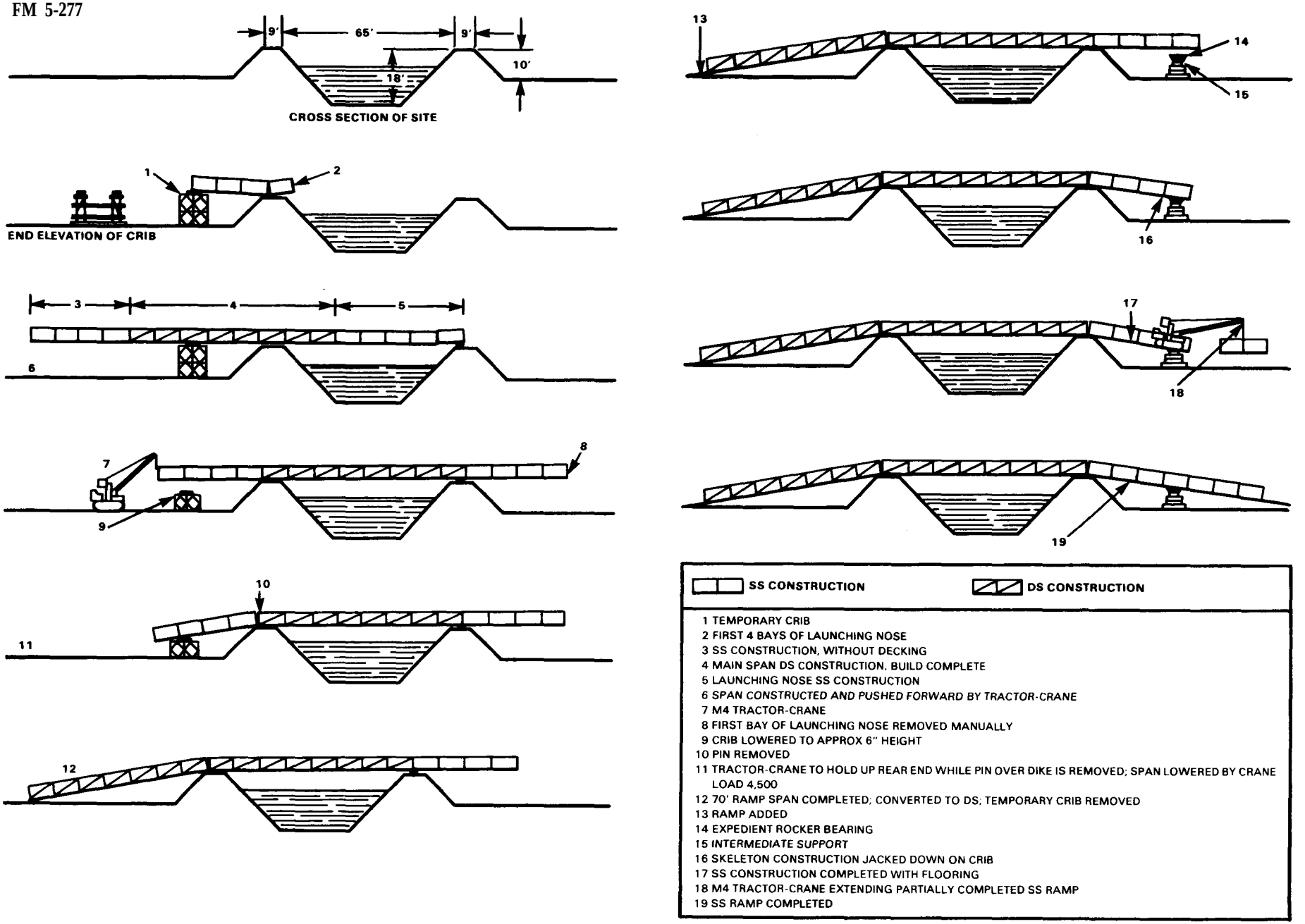


Figure 18-3 ***Method of assembling panel bridge, Bailey type, for bridging 65-foot (19.8 meters) diked canal***

This method can be used on all types of restricted sites, being particularly adapted to building from the top of canal dikes. Using the short tail and counterweight, it requires the least backspace of any launching method.

Forward packing at the edge of the gap must distribute the weight of the bridge over at least 3 feet (91.4 centimeters) of the bottom chord to prevent buckling. Rear packing supporting the tail must be low enough to give sufficient initial slope to counteract sag and bring the end posts over the far-bank bearings.

A timber 8 inches by 8 inches by 20 feet (20.4 centimeters by 20.4 centimeters by 6.1 meters) and a four-way block and tackle with ¾-inch (1.9 centimeters) diameter rope can be used as an improvised davit. Braced at a 45-degree angle (in double-story and triple-story assembly, against a transom at the lower end) so the upper end of the timber extends about 5 feet (1.5 meters) above and beyond the end of the trusses, each new panel can be accurately placed with the block and tackle suspended from the upper end of the timber.

Tail and counterweight are kept to a minimum by installing only such decking on the cantilever over the gap as required to operate the davits.

SWINGING ACROSS CANALS

Panel bridges can be swung across diked canals by assembling complete with launching nose or tail on top and parallel to the near-shore dike, and pivoting the bridge about its balance point on improvised pipe rollers.

LAUNCHING WITHOUT ROLLERS

Single-single bridges up to 40 feet (12.2 meters) long can be launched by soldiers without rollers by skidding on greased beams. Place greased timbers or greased stringers at the edge of the gap and 20 feet (6.1 meters) back under each line of trusses. Assemble the bridge on the skids with one transom per bay and no stringers or chess. Add three bays of tail with two transoms per bay and stringers in the last bay as a counterweight. Then push the bridge out over the gap with the aid of pinchbars and levers. Soldiers on the far bank lift the front end onto blocking. Remove the tail, add end posts, and jack down the bridge onto bearings. Complete the bridge by adding a second transom in each bay and laying decking and ramps. If end posts and bearings are not available, support the ends of the bridge as described in Chapter 22.

LAUNCHING BY FLOTATION

There are several advantages of launching by flotation. With this method a large assembly site is not needed and it can be away from the centerline of the bridge. Also, a launching nose or cantilever tail is not needed.

The disadvantages of launching by flotation are that the gap must be water-filled with sufficient unobstructed depth to float a loaded ponton. In a stream current over 3 feet (91.4 centimeters) per second, it is hard to maneuver the rafts. This method also takes longer than normal launching procedures.

Multiple spans

For launching intermediate spans by flotation, use pontons of suitable capacity under each end of the span to float it into position. Place cribbing on pontons to raise the bridge so the lower chord clears the top of the piers. Make sure the bridge overhangs pontons at each end; this provides clearance for maneuvering between piers when floating the span into position. Normally, launch the span on ponton rafts just downstream from the bridge site. The launching sequence for a typical 90-foot *triple-single* span on pontons (Figure 18-4, page 242) is as follows:

1 Assemble far-shore raft with two pontons and enough cribbing to keep end of bridge above pier. Assemble bridge on rollers on shore. Place launching rollers slightly higher than cribbing on raft.

2 Push bridge on rollers until it rests on far-shore raft with enough overhang to ensure clearance between raft and pier when span is in position over pier. Continue to push bridge and far-shore raft until end of bridge is near rocking rollers.

3 Assemble near-shore raft with four pontons and cribbing. Pump water into near-shore raft until it can be floated under shore end of bridge. If near-shore raft cannot be brought close inshore, place rocking rollers on cribbing on near-shore raft.

4 When raft is in position under bridge, pump water out until lower chord of span is supported by cribbing or rocking rollers (whichever is used) on raft. Continue pumping until span is raised clear of launching rollers on shore. If rocking rollers are used on raft cribbing, roll span into position and insert picket through lower chord of span and rocking roller to hold span in position.

5 Maneuver raft into position between piers.

6 Pump water into pontons until span is supported on piers. Remove rafts.

Note: Instead of pumping water into and out of the pontons to raise and lower the bridge, use jacks on top of each raft. To raise the bridge, jack it up and insert more cribbing. To lower the bridge, jack it up, remove cribbing, and jack the bridge down.

For a shore span with assembly on and off centerline, the launching sequences are as follows:

- For assembly on centerline, launch the shore span from rollers on the abutment along the bridge centerline. Place the front of the bridge on a raft and float out to seating on bent. Then jack up tail end, remove rollers, and jack bridge down on bearings. If end posts are not used and end panels of adjacent spans are connected by panel pins over the bent, cribbing may raise shore end of span too high and only top panel pins can be

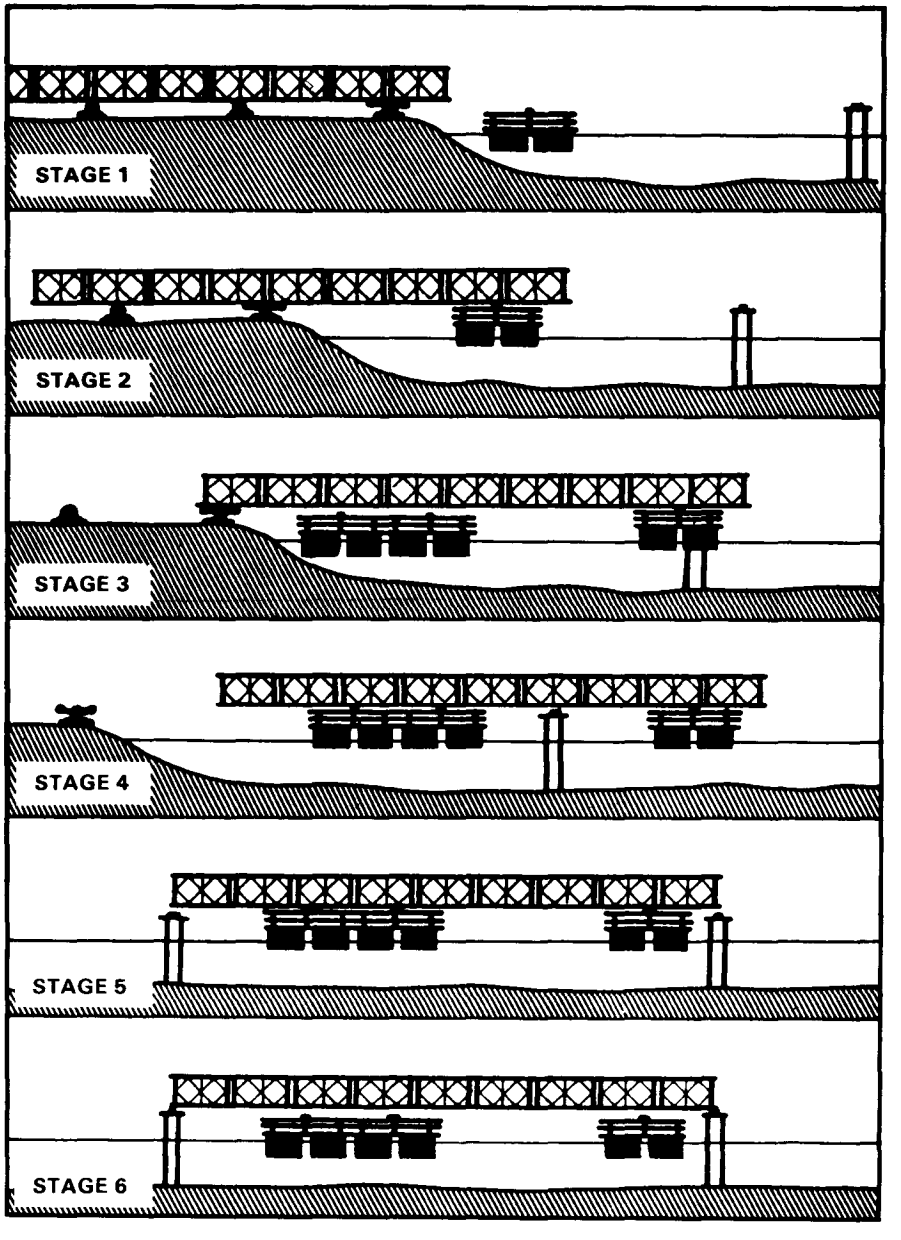


Figure 18-4 ***Stages of launching intermediate span by flotation***

inserted. Then remove top pins and jack down shore span to bearings on abutment.

- For assembly off centerline, assemble and launch the shore span in the same manner as the intermediate span, floating it into position between the abutment and first pier.

Single spans

For single spans launched by flotation with the assembly either on or off centerline, the launching sequences are as follows:

- For assembly on centerline, float front end of bridge on raft across gap as bays of bridge are added at tail which is on rollers on near shore. Use enough cribbing on raft to keep front end of bridge above far-bank abutment. Launching links and a short upturned nose ahead of raft can be used to raise the end high enough to clear the far-bank abutment.

- For assembly off centerline, assemble span off centerline of bridge and launch on rafts. Float span into position between abutments and lower into place. Cribbing on rafts must keep bridge above abutments and overhang must be enough to prevent grounding of rafts.

CHAPTER 19
LAUNCHING BY SINGLE GIRDERS

It may be advisable to launch a panel bridge one girder at a time. This method is advantageous when launching from an existing bridge where piers are wide enough to take the ends of a new span, but the existing bridge is not wide enough to launch the new span complete. Such launching is recommended when there is—

- An existing through-type panel bridge (Figure 19-1).
- An existing through-type civilian bridge where the width between side walls or trusses is less than 20 feet 8 ½ inches (6.32 meters) (Figure 19-2).
- An existing deck-type bridge where width of deck is less than 20 feet 8 ½ inches (6.32 meters) (Figure 19-2).
- A launching of span of panel bridge to a point much lower or of varying height, as to intermediate landing bay of a floating bridge in tidal water (Figure 19-3).

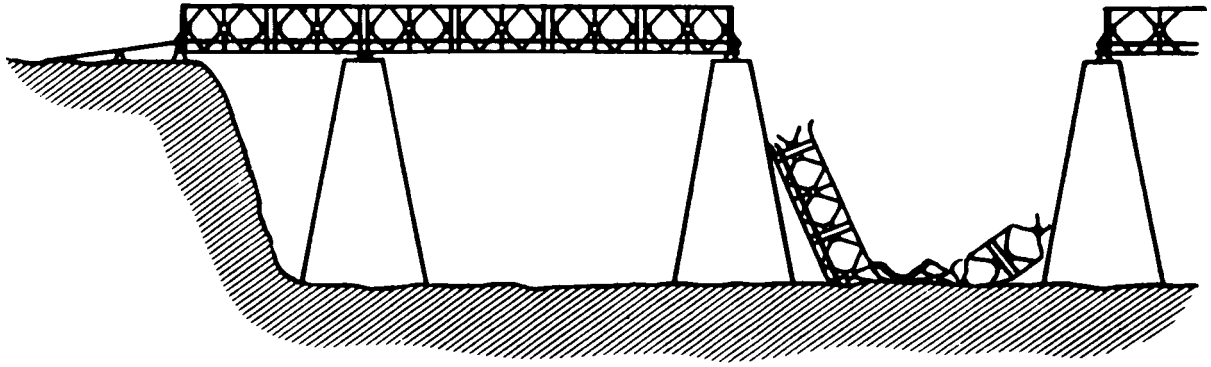


Figure 19-1 ***Damaged span of multispan panel bridge*** *(piers are wide enough to take ends of new span but existing bridge is not wide enough to launch new span complete)*

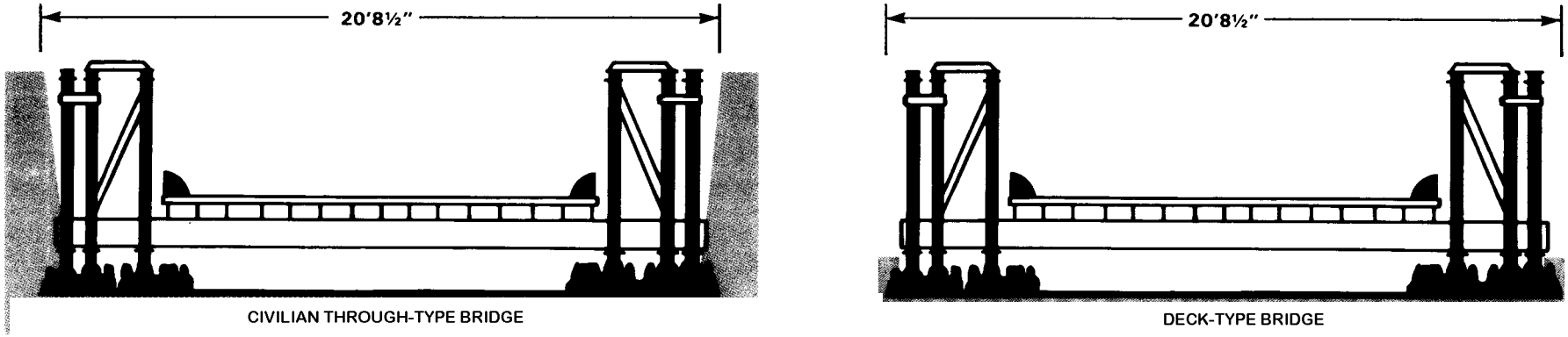


Figure 19-2 ***Necessary clearances for launching panel bridge from existing bridge***

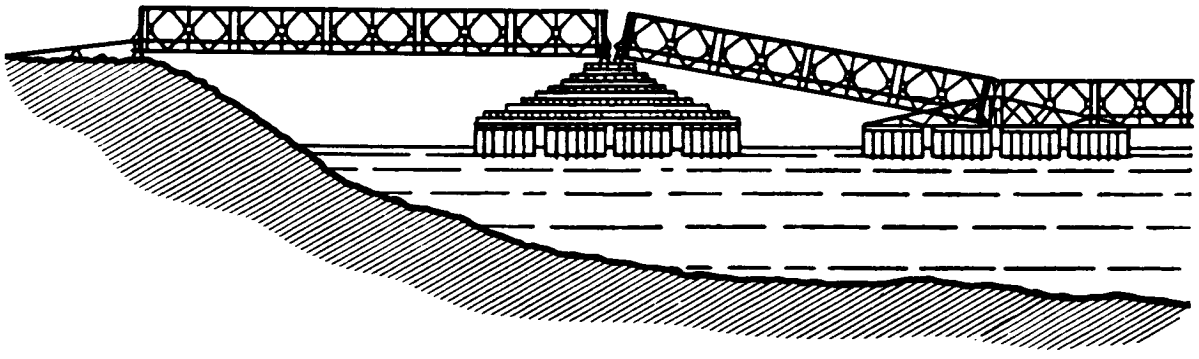


Figure 19-3 ***Intermediate landing bay of floating panel bridge in tidal water***

TYPES OF GIRDERS

A single girder may be made up of a single truss or of two or more trusses connected by bracing frames and tie plates. Five trusses are the maximum number that can be handled practicably. Figure 19-4 (page 246) shows girders with various combinations of two to five trusses. Single, double-, and triple-truss girders are used for through-type panel bridges. Any of the girders may be used for a deck-type panel bridge.

To save launching time, the wider girders are preferred to many narrow bridges. Four- and five-truss girders usually are used for multilane deck-type bridges.

Assembly sequence

The assembly sequence for launching by single girders is as follows:

1 Assemble girder on deck of existing bridges and then launch over gap.

2 Lower or slide it into position and then launch next girder.

3 To complete the bridge, add standard sway braces, transoms, stringers, and decking, or expedient bracing and flooring.

Methods of launching

Single-truss girders may be launched with gin poles or high line. Multitruss girders may be launched by any one of the following methods:

- Counterweight.
- Launching nose.
- Gin pole and snubbing tackle.
- High line.

Working parties

The size of working parties varies with size of girder. To assemble girders, divide soldiers into panel parties, pin parties, and bracing parties. Combine them to launch the girders. After the girders are in place, divide the soldiers into bracing and decking parties to complete the bridge.

Limitations

There are limitations of this kind of launching. Launching by single girders takes longer than the normal method of launching panel bridges.

A girder is always launched as a single-story girder; other trusses or stones are added after the girder has been launched. Bracing frames between trusses prevent overturning and give the girder rigidity. (However, when launching long girders in the wind with counterweight or launching nose, the end is subject to considerable whipping.) And plain rollers must be placed under every truss to support the girder evenly and prevent twisting.

LAYOUT OF ROLLERS

Plain rollers are used in sets under the girder, so each truss rests on a roller. In some cases, plain rollers must be staggered to prevent interference between rollers. Figure 19-4 shows the arrangement of plain rollers in sets under the girder.

Rocking rollers cannot be staggered. When trusses are spaced 1 foot 6 inches (5.3 centimeters) on center, rocking rollers are placed under every truss. The two outer trusses are spaced 8½ inches (21.6 centimeters) on centers by tie plates and a single rocking roller is placed under the inner of the two trusses (Figure 19-5, page 247). Remove the outer guide roller. Wedge shims between tie plate and chord-channel flanges to prevent outside truss from slipping down. Under the four-truss (2-foot 21½-inch) (67.4 centimeter) girder, the rocking rollers are placed under the outer trusses (Figure 19-6, page 247).

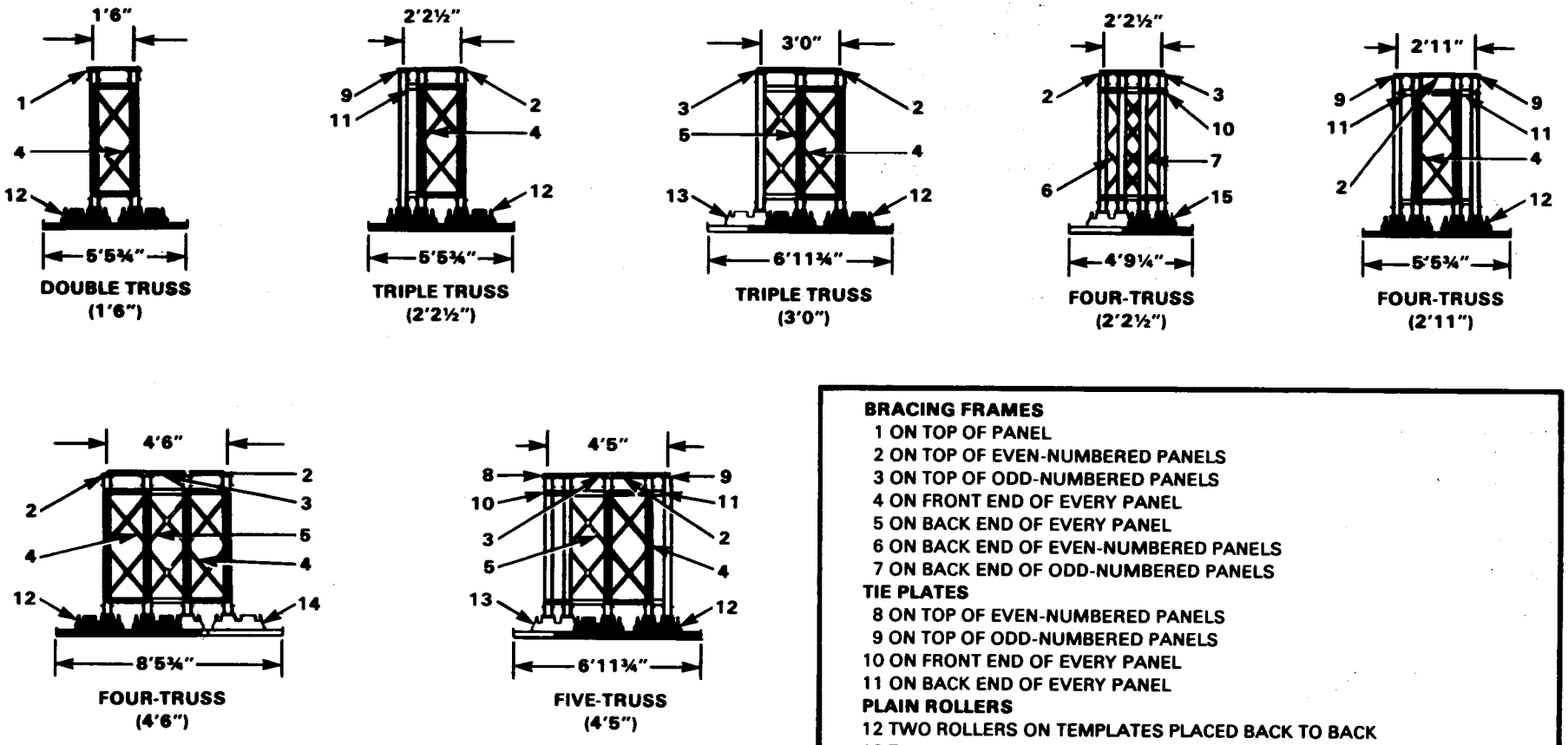


Figure 19-4 ***Multitruss girders and arrangement of plain rollers for launching***

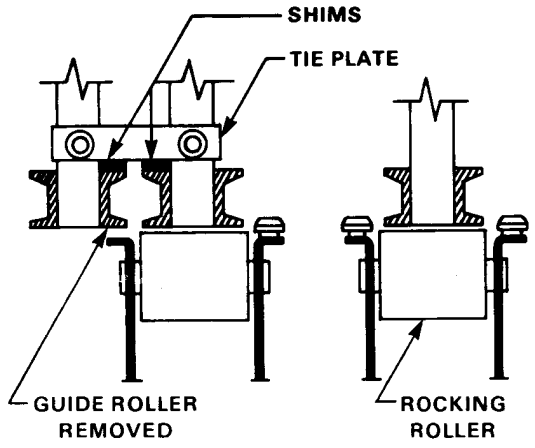


Figure 19-5 ***Arrangement of rocking rollers under a*** *triple-truss* ***girder***

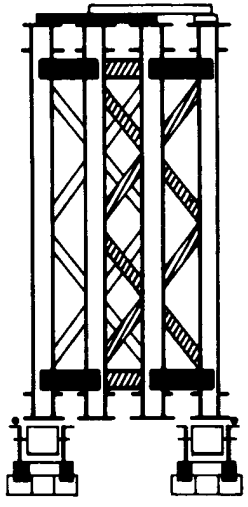


Figure 19-6 ***Arrangement of rocking rollers under a*** *four-truss* ***girder***

The procedure for laying out sets is—

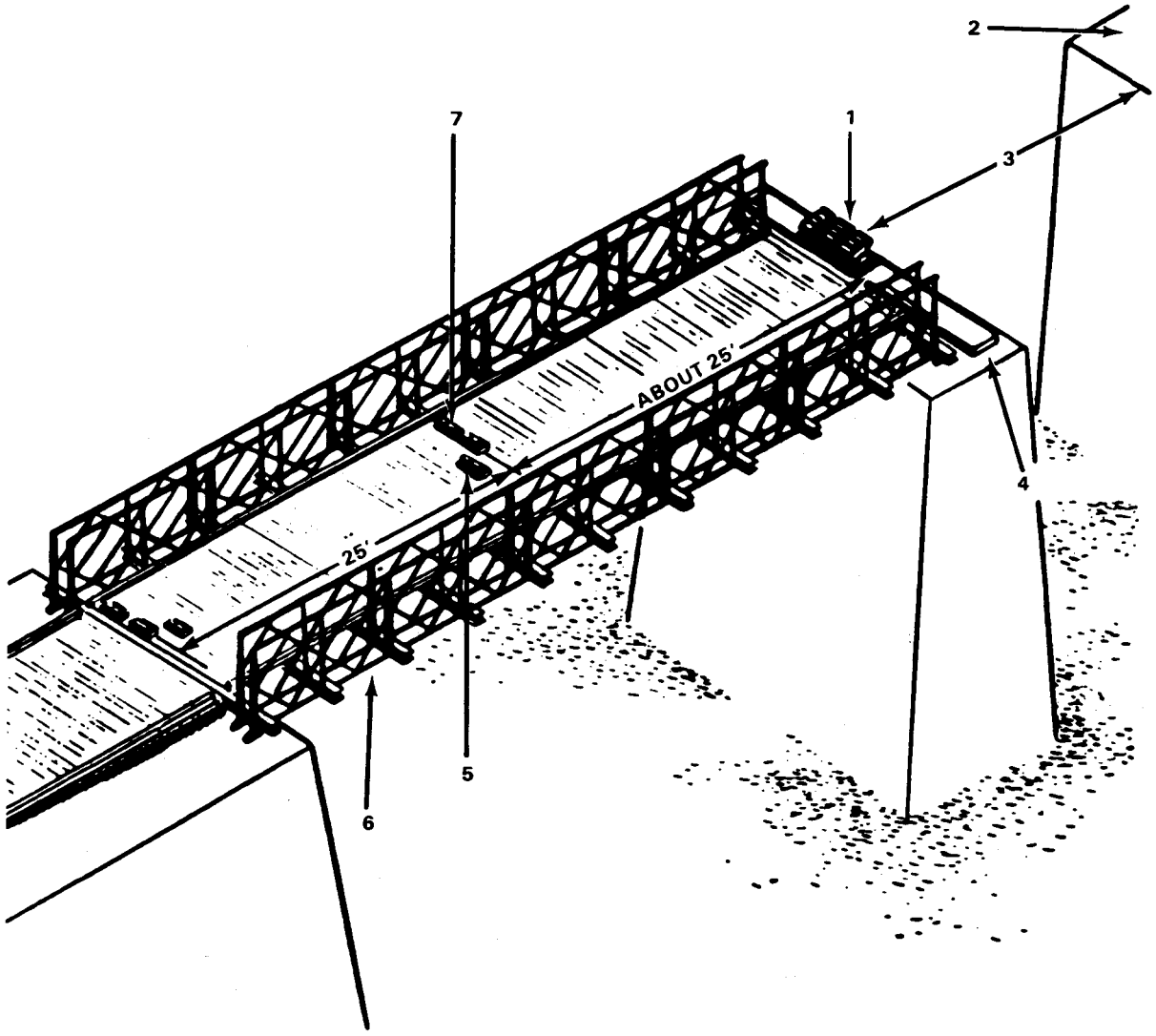
- Use rocking rollers at the edge of the gap and place plain rollers at about 25-foot (7.6-meter) intervals back along the girder (Figure 19-7, page 248). With double-truss girders, plain rollers can be used instead of rocking rollers at the edge of the gap.
- When using a counterweight (Figure 19-8, page 249) or launching nose (Figure 19-9, page 250), assemble and launch the girder on the side of the existing bridge nearest its final position. Assemble a second girder simultaneously at the other side of the deck of the existing bridge. Lay out rollers accordingly.
- When using a gin pole and snubbing tackle, two gin poles, or a high line, lay out the rollers so as to assemble and launch the girder along the centerline of the bridge.
- When launching from an existing panel bridge, place all plain rollers directly over transoms to avoid overstressing stringers (Figure 19-7). Set rocking rollers preferably on cribbing directly on the pier. If it is necessary to place the rocking rollers on the deck of the existing panel bridge, place them directly over the end transom. If the total launching weight on rocking rollers is more than 14 tons (12.7 metric tons), use two transoms under the rollers; if the launching weight is more than 28 tons (25.5 metric tons), wedge the cribbing under the center of the end transoms.

ASSEMBLY OF GIRDERS

The girder may have from two to five trusses (Figure 13-10).

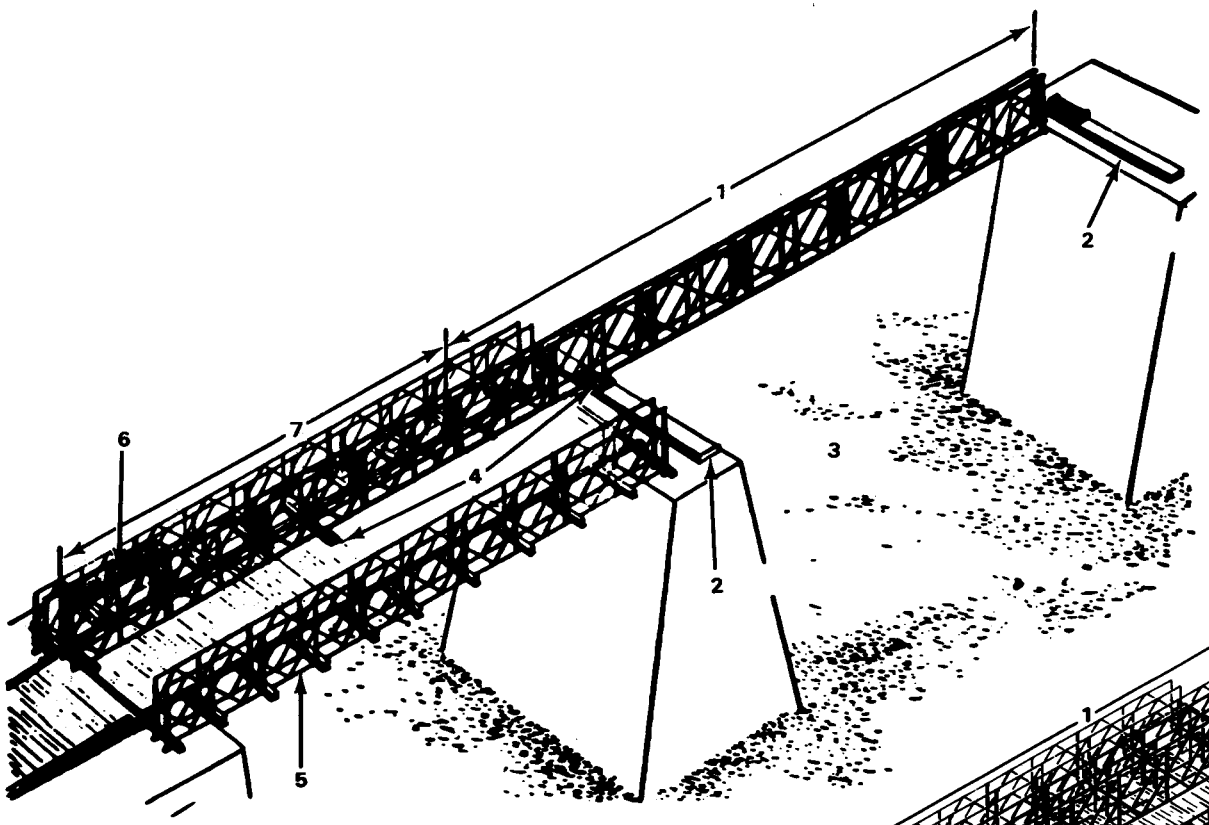
Connect trusses of multitruss girders at every possible place by bracing frames and tie plates across the top chords and ends of panels. All tie-plate bolts must be tight and shims must be used to prevent the outer truss from slipping down when the end of the girder is over the gap (Figure 19-5). In girders with outer trusses spaced 8 ½ inches (21.6 centimeters), insert panel pins connecting the nose to the main girder from the inside so the nose can be disconnected after launching. In both the main girder and the nose, always insert the pins from the outside toward the centerline of the girder.

Place end posts on the front end of all trusses before launching, except when using a launching nose, in which case place the front end posts after the girder has been launched. Place the rear-end posts when the girder is in position for jacking down. Table 19-1 (page 250) lists the parts required to assemble each type of girder.



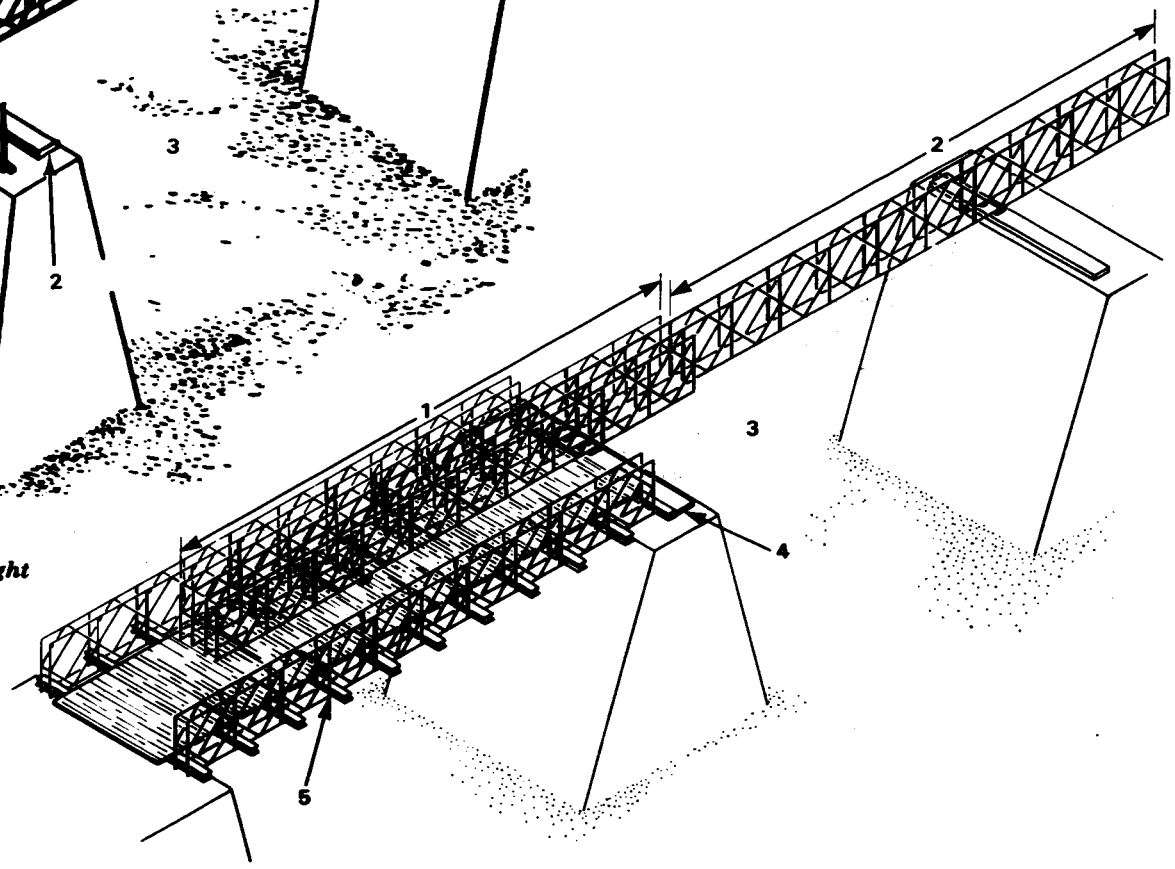
1 ROCKING ROLLERS
2 PIER
3 GAP
4 SKIDDING BEAM
5 THIRD ROLLER STAGGERED
6 EXISTING BRIDGE
7 ROLLER PLACED DIRECTLY OVER TRANSOM

Figure 19-7 ***Layout of launching rollers for launching a triple-truss girder from existing panel bridge***



1 SIX-BAY DOUBLE-TRUSS GIRDER
2 SKIDDING BEAM
3 GAP
4 PLAIN ROLLERS
5 EXISTING BRIDGE
6 2-TON COUNTERWEIGHT
7 FOUR-BAY TAIL

Figure 19-8 ***Launching a single girder with a counterweight***



1 SIX-BAY FOUR-TRUSS GIRDER (2'11")
2 FIVE-BAY DOUBLE-TRUSS LAUNCHING NOSE
3 GAP
4 SKIDDING BEAM
5 EXISTING BRIDGE

Figure 19-9 ***Launching a four-truss girder with a launching nose***

LAUNCHING OF GIRDERS

There are several methods of launching by single girders. These are the counterweight, launching-nose, gin-pole and snubbing-tackle, direct-lift, and high-line methods.

Counterweight method

Launch a single girder by counterweight as follows:

- Add the counterweight to the rear end of the girder to balance the front end of the girder as it is pushed on rollers out over the gap. Long girders may be kept in line by using side guys and a pull winch from the far pier. When across the gap, the front end lands on rollers at the far bank or pier, or on landing-bay pier of a floating bridge. Then disconnect the counterweight, attach the rear end posts, remove the rollers at each end, and jack down the girder onto a skidding beam.
- Girders may be counterweighted either by adding weights to the last bay of a short tail on the girder or by making the girder of the same assembly and twice as long as the span so the tail alone will counterbalance the span. Table 19-2 lists weights needed on short tails to counterweight various spans of multitruss girders. (Longer spans cannot be launched by this method because of insufficient lateral stability.) If the long tail is used, it may be disconnected after the first girder is launched, and used for a second girder.

Table 19-1 ***Parts required to assemble single-truss and multitruss girders***

ITEM	NUMBER OF PARTS PER TWO BAYS							
	TRUSSES							
	ONE	TWO	THREE	THREE	FOUR	FOUR	FOUR	FIVE
	SPACING OF OUTER TRUSSES							
		1′6″	2′2½″	3′0″	2′2½″	2′11″	4′6″	4′5″
Bolt, bracing		16[2]	24	24	32[4]	36	36[2]	48
Frame, bracing		4[2]	3[3]	6	4[4]	3[3]	9[2]	6
Panel	2	4	6	6	8	8	8	10
Pin, panel[1]	4	8	12	12	16	16	16	20
Plate, tie			6		8	12		12
Post, end	ADD ONE END POST AT EACH END OF EACH TRUSS							

[1]Add two panel pins at end of each truss
[2]Add one bracing frame and four bracing bolts in last bay
[3]Add one bracing frame in last bay
[4]Delete one bracing frame and four bracing bolts from last bay

The counterweight method is useful when site conditions at the far side prevent use, removal, or disposal of a launching nose, or erection of a gin pole or high line. When launching long girders of a deck-type bridge, a counterweight permits tipping the far end directly onto the pier without jacking down.

Launching-nose method

Launch a single girder by the launching-nose method as follows:

- Attach a lightweight launching nose to the front end of the girder, and push the girder with nose on rollers out over the gap. To compensate for sag, launching-nose links may be used in the same manner as when launching the normal panel bridge. Long girders may be kept in line by using side guys and a pull winch. When across the gap, the nose lands on rollers on the far bank. Then disconnect nose, attach front end posts, remove rollers at each end, and jack down the girder onto skidding beams.
- Table 19-3 (page 253) lists the types and lengths of noses needed to launch multi—truss girders. Single-truss girders cannot be launched by this method. Brace launching noses the same as the girder. When launching the triple-truss girder with an eccentric double-truss nose, the nose must be dismantled bay by bay as it passes over the landing rollers. Otherwise, the nose beyond the landing rollers twists the girder, and may cause failure.

- The launching-nose method is used for longer girders, where sag is appreciable. It can also be used for girders too heavy for a gin pole or high line. Launching by this method is easier than with a counterweight, because the girder with nose is lighter than the girder with counterweight.

Gin-pole and snubbing-tackle method

Launch a single girder by the gin-pole and snubbing-tackle method (Figure 19-10, page 252) as follows:

- Erect a gin pole at the far bank or pier. Rig tackle from the gin pole to the front end of the girder with the fall line running to the winch of a truck on the bridge or bank. When a truck-mounted crane or tractor is used at the tail of the girder, lead the fall line around it by a snatch block at the side of the bridge. For long, heavy girders, attach guy lines near the center of the girder on each side and control by winches on trucks to each side of bridge. The girder rides on rollers on the near bank. Brake it by snubbing tackle attached to the rear end of the girder to keep it upright and to lift it onto the bearings. Power applied to the hauling winch pulls the girder across the gap. Move a truck-mounted crane forward with the girder, keeping the snubbing line taut to prevent too rapid movement. When the girder has passed its balance point, let it dip about one-tenth of its length to lessen stress in

Table 19-2 ***Required counterweight for various spans of multitruss girders***

SPAN (ft)		40	50	60	70	80	90
DOUBLE-TRUSS GIRDER AND TAIL	Bays in tail	3	3	4	4	5	5
	Counterweight (tons)	1.1	2.3	2.0	3.5	3.0	4.2
	Total weight on rocking rollers (tons)	5.6	7.5	8.6	10.4	11.4	13.3
TRIPLE-TRUSS GIRDER AND TAIL WITH OUTER TRUSSES SPACED 2'2½"	Bays in tail	3	3	4	4	5	5
	Counterweight (tons)	1.6	3.3	2.9	4.8	4.4	6.2
	Total weight on rocking rollers (tons)	8.3	10.9	12.4	15.1	16.5	19.3
TRIPLE-TRUSS GIRDER AND TAIL WITH OUTER TRUSSES SPACED 3'0"	Bays in tail	3	3	4	4	5	5
	Counterweight (tons)	1.7	3.5	3.0	4.9	4.4	6.3
	Total weight on rocking rollers (tons)	8.5	11.3	12.7	15.6	17.0	19.9
FOUR-TRUSS GIRDER AND TAIL WITH OUTER TRUSSES SPACED 2'2½"	Bays in tail	3	3	4	4	5	5
	Counterweight (tons)	2.1	4.5	3.9	6.4	5.9	8.2
	Total weight on rocking rollers (tons)	11.0	14.7	16.5	20.3	22.2	25.8
FOUR-TRUSS GIRDER AND TAIL WITH OUTER TRUSSES SPACED 2'11"	Bays in tail	3	3	4	4	5	5
	Counterweight (tons)	2.1	4.4	4.0	6.3	5.8	8.2
	Total weight on rocking rollers (tons)	11.0	14.4	16.5	20.1	22.0	25.7
FOUR-TRUSS GIRDER AND TAIL WITH OUTER TRUSSES SPACED 4'6"	Bays in tail	3	3	4	4	5	5
	Counterweight (tons)	2.2	4.6	4.1	6.6	6.1	8.5
	Total weight on rocking rollers (tons)	11.4	15.1	17.2	21.0	23.0	26.7
FIVE-TRUSS GIRDER AND TAIL	Bays in tail	3	3	4	4	5	5
	Counterweight (tons)	2.7	5.6	5.0	8.0	7.4	10.3
	Total weight on rocking rollers (tons)	13.9	18.4	20.8	25.5	28.0	32.4

the tackle. After the girder is across the gap, the gin pole and truck-mounted crane lift it directly onto the bearings.

- When a truck-mounted crane is not available, two gin poles may be used, one on each bank. Attach both gin-pole lines to the front end of the girder, which is pulled over the gap by taking up on the far gin-pole line and slacking off on the near gin-pole line. When the front end of the girder is over the far bank, change the line from the near gin pole from the front to the rear of the girder. Then lower the girder onto its bearings.

- This method is better for short spans, since long girders are heavy and difficult to handle. It also saves bridge equipment, because it eliminates the need for either a launching nose or counterweight. In addition to handling girders, the gin pole and truck-mounted crane can be used to telegraph transoms and decking into place.

Direct-lift method

Launch a single girder by the direct-lift method as follows:

- Assemble the girder on ground beside the piers. Use two cranes or gin poles to lift the girder into place on the piers. In case of a water gap, the girder may be floated out to the piers and lifted into place by cranes on rafts or on the piers. Cranes are not needed if the piers are low enough so the girder can be floated into place and lowered onto the piers by pumping water into the raft pontons.

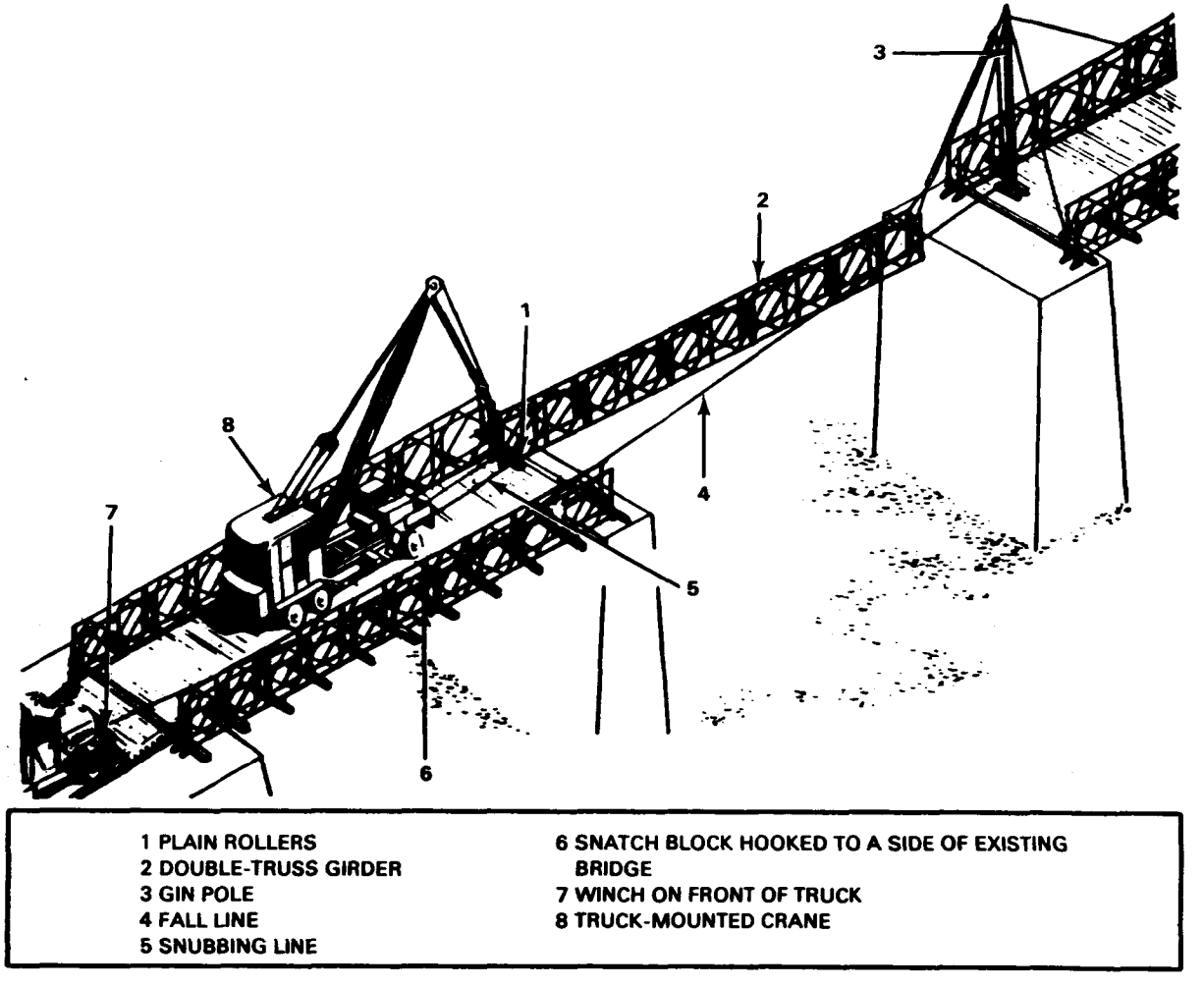
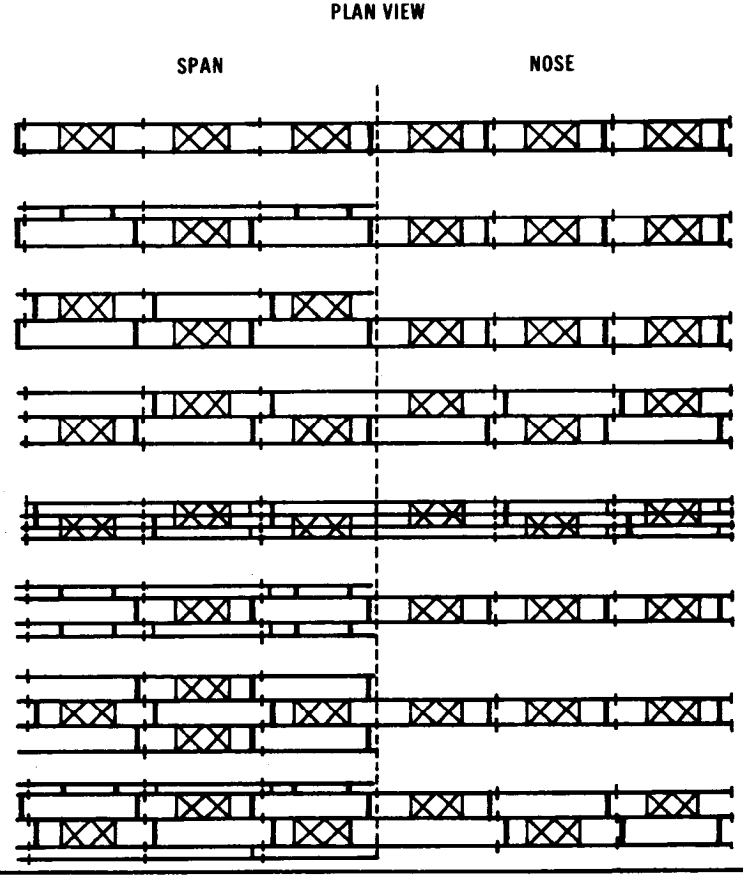

1 PLAIN ROLLERS
2 DOUBLE-TRUSS GIRDER
3 GIN POLE
4 FALL LINE
5 SNUBBING LINE
6 SNATCH BLOCK HOOKED TO A SIDE OF EXISTING BRIDGE
7 WINCH ON FRONT OF TRUCK
8 TRUCK-MOUNTED CRANE

*Figure 19-10 **Launching a double-truss girder with a gin pole and snubbing tackle***

- The length of girder that can be launched by this method is limited by the capacity of the cranes. If the girders are short and light, a single crane can be used.

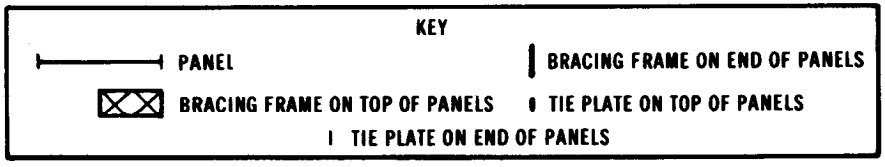
Table 19-3 ***Composition of launching noses and launching weights of multitruss girders***

TYPE OF GIRDER	SPACING OF OUTER TRUSSES	TYPE OF NOSE	SPAN (ft)[1] 40	50	60	70	80	90	100	110
			NUMBER OF BAYS IN NOSE / LAUNCHING WEIGHT IN TONS (No / Wt)							
DOUBLE-TRUSS	1'6"	DOUBLE-TRUSS	4 / 5.0	5 / 6.4	6 / 7.6	7 / 8.8	8 / 10.2	9 / 11.4		
TRIPLE-TRUSS	2'2½"	DOUBLE-TRUSS[2]	4 / 6.2	5 / 7.8	6 / 9.3	6 / 10.3	7 / 11.8	8 / 13.4		
TRIPLE-TRUSS	3'0"	DOUBLE-TRUSS[2]	4 / 6.3	5 / 8.0	5 / 8.9	6 / 10.5	7 / 12.0	8 / 13.7		
TRIPLE-TRUSS	3'0"	TRIPLE-TRUSS	4 / 7.6	5 / 9.6	6 / 11.4	7 / 13.4	8 / 15.2	9 / 17.2		
FOUR-TRUSS	2'2½"	FOUR-TRUSS	4 / 9.9	5 / 12.4	6 / 14.8	7 / 17.3	8 / 19.8	9 / 22.3	10 / 24.8	
FOUR-TRUSS	2'11"	DOUBLE-TRUSS	3 / 6.8	4 / 8.6	5 / 10.6	6 / 12.4	6 / 13.6	7 / 15.5	8 / 17.4	9 / 19.2
FOUR-TRUSS	4'6"	DOUBLE-TRUSS	3 / 7.0	4 / 8.9	5 / 10.9	6 / 12.8	6 / 14.1	7 / 15.9	8 / 17.9	9 / 19.8
FIVE-TRUSS	4'5"	TRIPLE-TRUSS	4 / 10.0	4 / 11.6	5 / 14.1	6 / 16.6	7 / 19.2	8 / 21.6	8 / 23.2	9 / 25.7



[1]Longer spans cannot be launched by this method because of insufficient lateral stability

[2]Remove nose as each bay clears far-shore landing rollers


KEY
PANEL
BRACING FRAME ON END OF PANELS
BRACING FRAME ON TOP OF PANELS
TIE PLATE ON TOP OF PANELS
TIE PLATE ON END OF PANELS

High-line method

Launch a single girder by the high-line method (Figure 19-11) as follows:

- Rig a high line of suitable capacity across the gap along the centerline of the bridge. Suspend the girder from the high line, pull it over the gap, and lower it onto skidding beams. Attach the trolleys on the high line to slings on the girder near the quarter points. Roll the girder on the approach span to its balance point on the first roller before it is carried by the high line. Use tag lines at both ends of the girder to control it during launching.

- This method is useful for launching deck-type bridges where the girder has to be lowered a considerable distance to the skidding beams. In addition to handling the girders, the high line can be used to carry out the transoms and decking, and where trestle-approach spans are used, it can be used to carry out bridge parts for the approach spans. This method also eliminates the need for either a launching nose or counterweight. The capacity of high lines is usually limited to short single or double-truss girders. Table 19-4 lists the weight, in tons, of various lengths of girders.

JACKING DOWN

Jack down the girders either with a jack under each end post or with jacks under an equalizing beam supporting the underside of the girder (Figure 19-12). Work the jacks in unison so the girder is lowered evenly. During the lowering, guy the girders to prevent

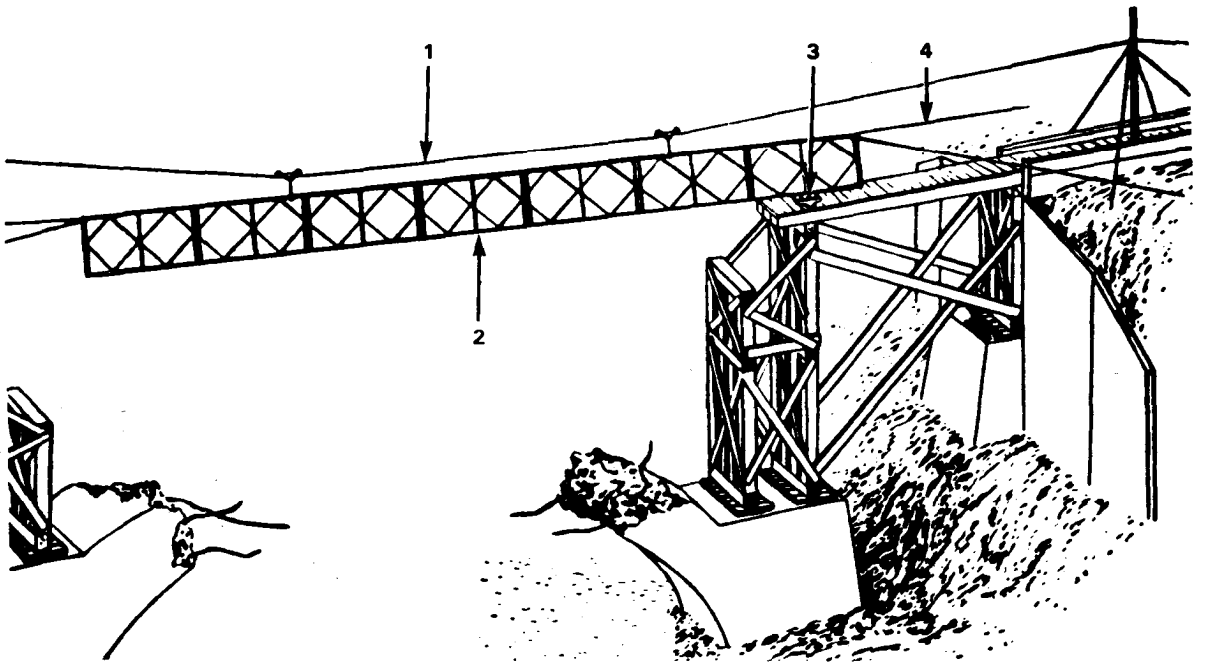


Figure 19-11 ***Launching a single-truss girder with a high line***

Table 19-4 ***Weight, in tons, of single-truss and multitruss girders***

NUMBER OF TRUSSES	SPACING OF OUTER TRUSSES	SPAN (ft) 30	40	50	60	70	80	90	100	110	120
One		0.9	1.2	1.5	1.8	2.1	2.4	2.6	2.9	3.2	3.5
Two	1'6"	1.9	2.5	3.2	3.8	4.4	5.1	5.7	6.4	7.0	7.6
Three	2'2½"	2.8	3.7	4.6	5.5	6.5	7.4	8.3	9.3	10.2	11.1
Three	3'0"	2.8	3.8	4.8	5.7	6.7	7.6	8.6	9.5	10.5	11.4
Four	2'2½"	3.7	4.9	6.2	7.4	8.7	9.9	11.1	12.4	13.6	14.8
Four	2'11"	3.7	4.9	6.1	7.4	8.6	9.8	11.1	12.3	13.5	14.7
Four	4'6"	3.8	5.1	6.4	7.7	9.0	10.3	11.5	12.8	14.1	15.4
Five	4'5"	4.7	6.2	7.8	9.3	10.9	12.5	14.0	15.6	17.1	18.7

Note:
Without end posts

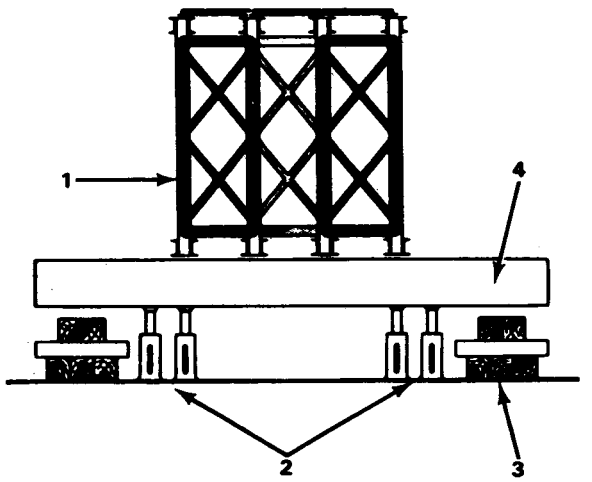


Figure 19-12 ***Jacks under four-truss girder using an equalizing beam***

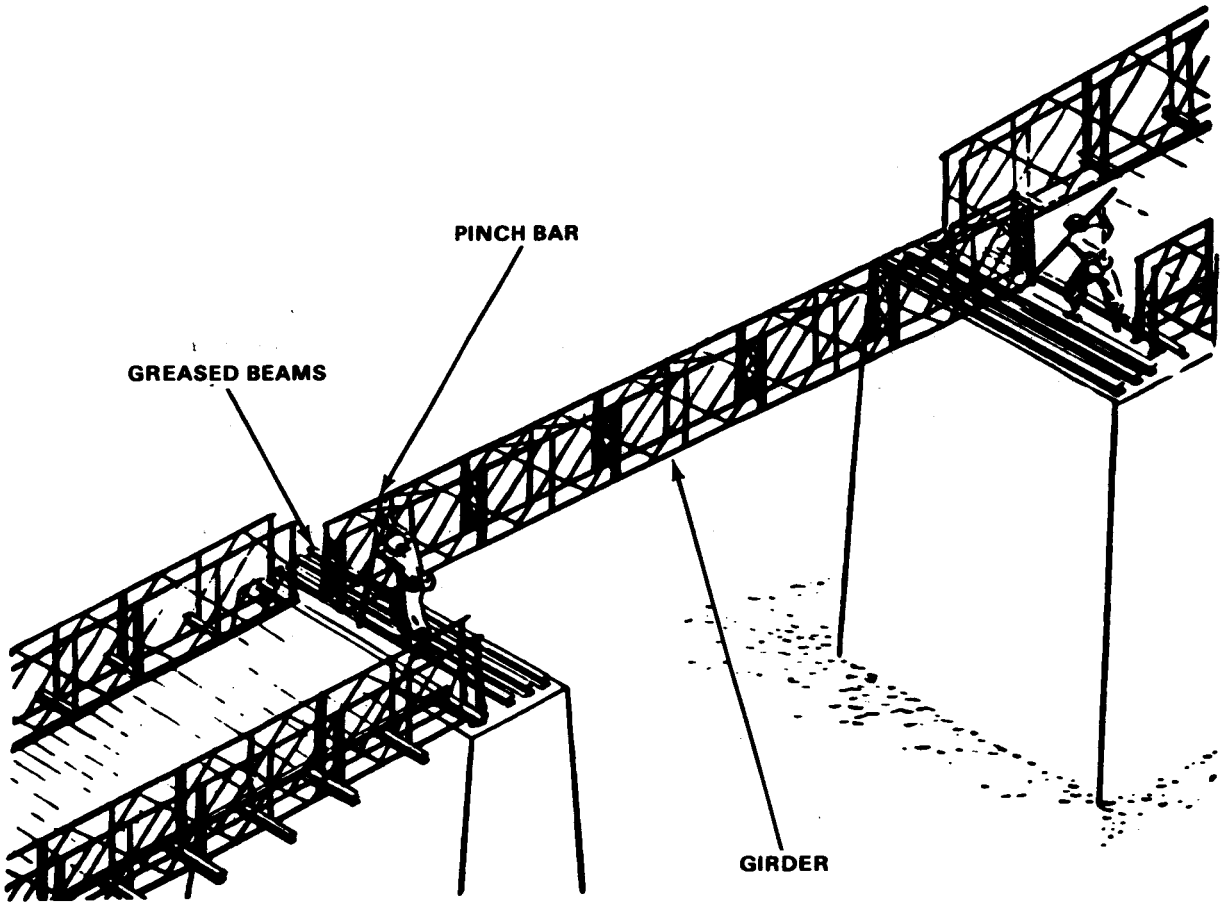


Figure 19-13 ***Skidding a girder into place by prying with pinchbars***

overturning. To lower the girder in its final stage, place equalizer beam under top chord as in Figure 16-18. Place cribbing under the bottom chords or equalizer beam to prevent the girder from dropping if it slips off the jacks. If the distance to be lowered is great, lower the girder by successive stages. When truck-mounted cranes or gin poles are available at each end of the bridge, lower the girders directly on the bearings.

SKIDDING AND SQUARING UP

After launching, move the girder into position by truck cranes, or skid it into position on greased skidding beams by prying with panel levers or pinchbars (Figure 19-13). Panel-bridge stringers are preferred for skidding beams, but I-beams or timber beams may be used.

After the first girder is lined up with the existing bridge, square up the second girder with the first. If the trusses cannot be moved in a longitudinal direction without rollers, reinsert rollers after skidding.

COMPLETION OF BRIDGE

For normal through-type assembly, complete the bridge bay by bay, working out from the near shore as follows:

1 Insert sway braces of first bay with adjusting collars on the same side of bridge. Use two lashings from centers of bottom brace to hold center of sway braces up until ends are pinned in place. Do not tighten.

2 Place transoms in first bay. A truck-mounted crane with gin pole on far bank may be used to telegraph transoms into place, or they may be placed by hand. In the telegraph method, attach to the transom both a line from the gin pole on the far bank and a line from the crane on the near bank. Then pick up the transom and place it by taking up the gin-pole line and slacking off on the crane line. Use a tag line on the transom to guide it. When handling it manually, push the transom out from the bank and swing it into position with the aid of ropes attached to the top chords. The transoms are difficult to fit at first, but this becomes easier as more bays are completed.

3 Place stringers in first bay.

4 Remove vertical bracing frames and insert rakers. Do not tighten.

5 Repeat above procedure to install sway braces, transoms, stringers, and rakers in second bay.

6 After bracing members are inserted in second bay, tighten all bracing in first bay and lay chess and ribbands in first bay.

7 Add remainder of decking in the same manner.

8 Install ramps.

Deck-type bridges take either standard panel-bridge decking or expedient timber decking. For details of deck-type bridges, see Chapters 12 and 13.

CHAPTER 20
BRIDGES ON BARGES

The panel bridge on barges consists of a standard panel bridge supported on floating piers made from river or coastal barges of suitable type and capacity. Special spans or parts are used to provide hinged joints between floating bays (Figure 20-1).

PIERS

Piers consist of barges or vessels suitably prepared to support the panel-bridge superstructure. The several kinds of piers are—

- Floating-bay piers, which support the floating bays in the interior of the bridge.
- Landing-bay piers, which support the shore end of the floating bay and the riverward end of either the fixed-slope landing bay or the variable-slope landing bay.
- Intermediate landing-bay piers, which support the shore end of the fixed-slope landing bay and the riverward end of the variable-slope landing bay. The intermediate landing-bay pier is not used without the fixed-slope landing bay.

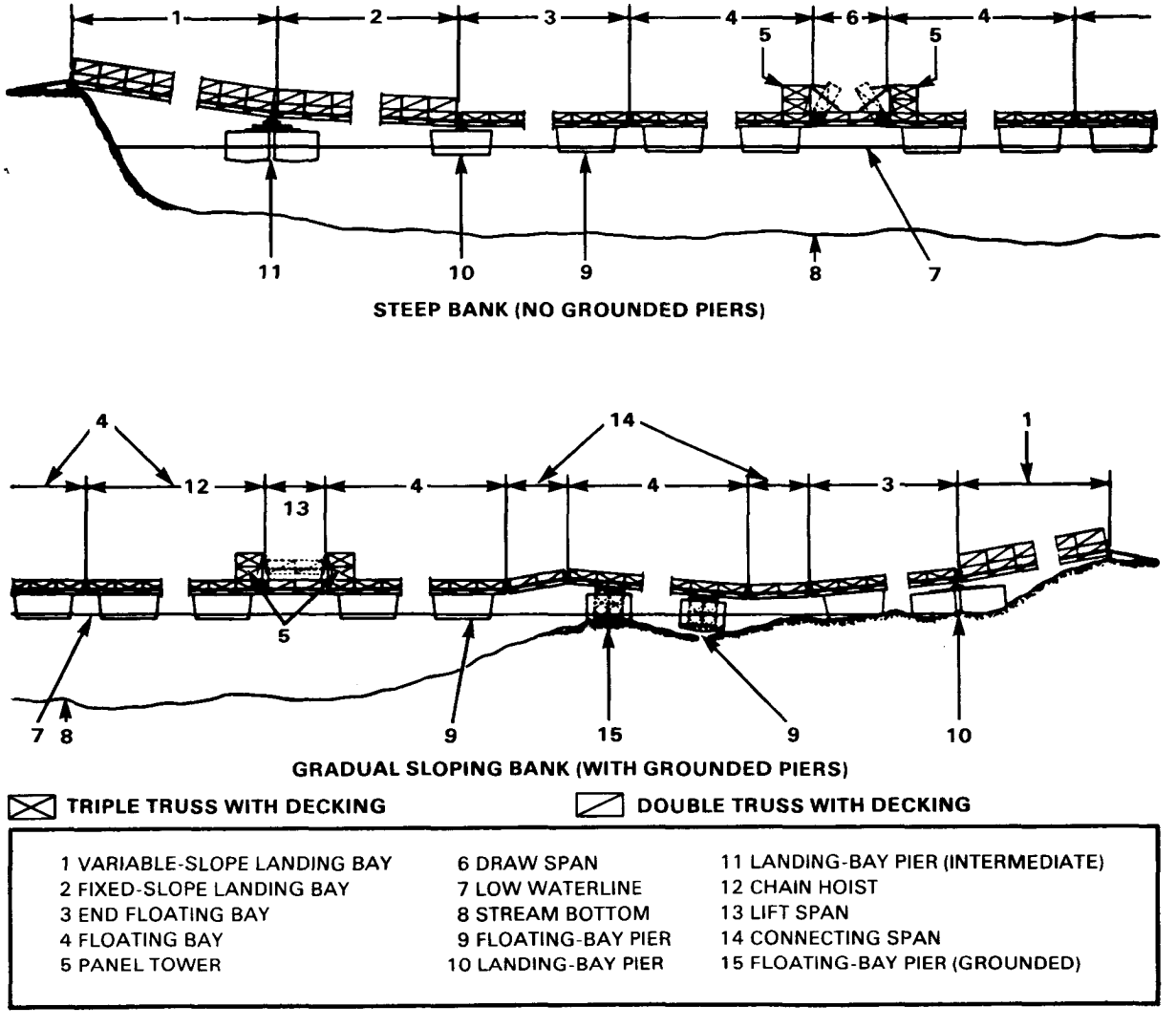


Figure 20-1 ***Nomenclature of panel bridge on barges***

BAYS

The span between two articulating points supported by two floating piers or between the shore and a floating pier is called a bay (Figure 20-2). The several-kinds of bays are-

- Floating bays, which are the interior of the bridge from the end floating bay on the near shore to the end floating bay on the far shore. They are supported near each end by floating-bay piers.
- End-floating bays, which form the continuation of the bridge between the floating bays and the landing bays. They are supported by a landing-bay pier and a floating-bay pier.
- Landing bays, which form the connection between the end floating bay and the bank. There are two types of landing bays: the variable-slope landing bay, which spans the gap between the bank-seat and the landing-bay pier (or the intermediate landing-bay pier if a fixed slope landing bay is used); and the fixed-slope landing bay, which, spans the gap between, the intermediate landing-bay pier and the landing-bay pier.

SPECIAL SPANS

Special spans include connecting spans, lift spans; and draw spans. Connecting spans connect two adjacent floating bays where barges are grounded. They each provide two articulating points to compensate for the changes in slope between the floating bays. Lift spans (Figure 20-3) connect two adjacent floating bays. They can be lifted vertically by use of block and tackle or chain hoists to allow passage of water traffic through the bridge. Draw spans provide a wider gap between adjacent floating bays for passage of river traffic. They can be split in the middle and each half pivoted up.

DESIGN AND CAPACITIES OF BARGES

Coastal and river barges differ widely in construction and capacity throughout the world. In Europe and the Americas, barges are generally flatbottomed. Barges with round or semiround keels are also found on European canals and rivers (Figure 20-4).

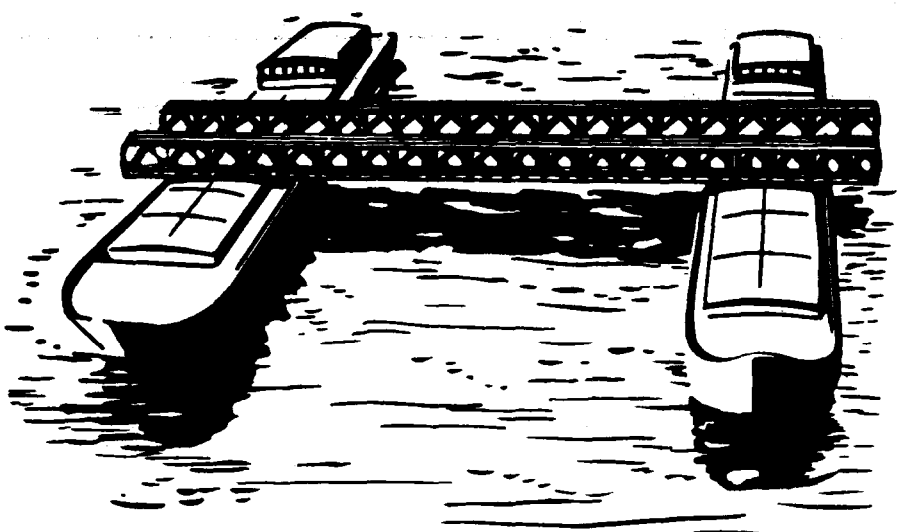


Figure 20-2 ***Floating bays***

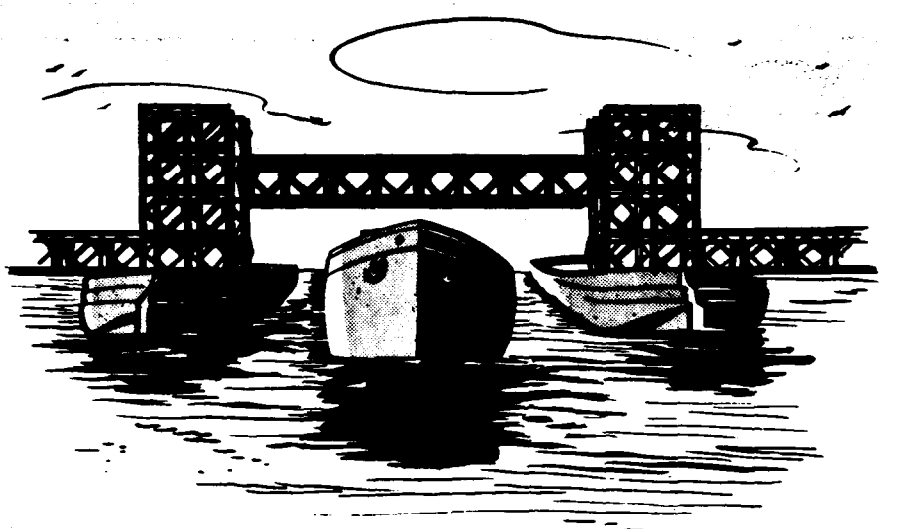


Figure 20-3 ***Panel-bridge lift span***

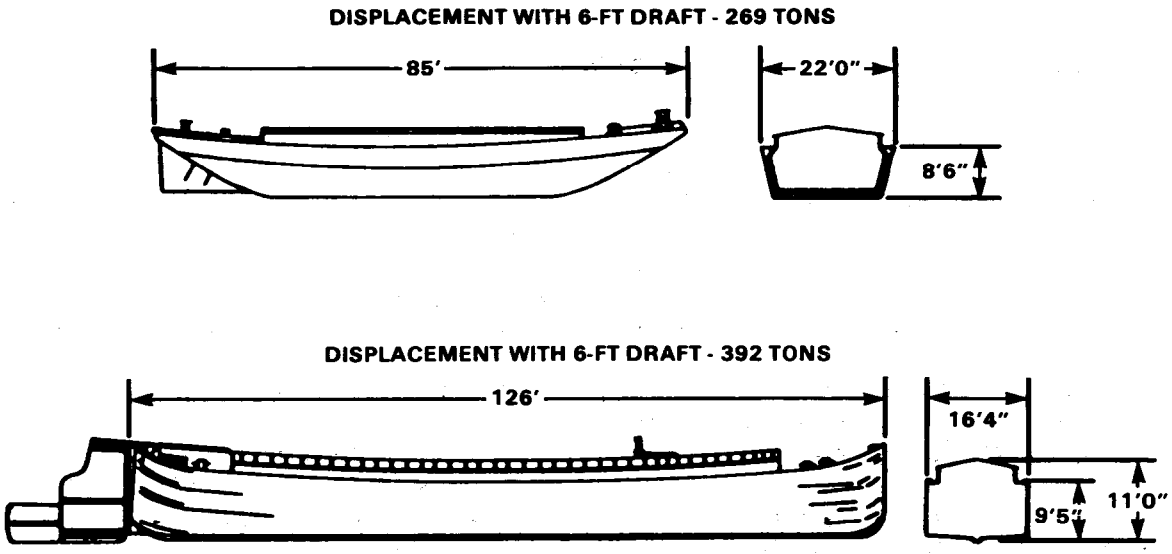


Figure 20-4 Typical European barges

Asiatic barges have less capacity than European or American barges. Generally, European and American barges have a capacity of from 80 to 600 tons (73 to 546 metric tons). The general condition of the barge has a direct effect on its use in a bridge.

Ribs

Structural ribs of barges are designed for bending stresses induced by water pressure on the outside of the hull. They are normally bulb-angled steel sections 5½ to 7 inches (14 to 17.8 centimeters) deep, closely spaced, and curved rather than straight. Ribs should not be loaded as struts unless they are braced and load is distributed. To distribute the load, timber cribbing can be used along the gunwale directly over the ribs. If the rib is not curved and the length of rib from deck to keel does not exceed 10 feet (3.1 meters), each rib will support approximately 5 tons (4.6 metric tons).

Decks

Barge decks are designed for distributed loads. A wide variation of deck design exists and care must be taken in estimating their capacity. European flat-bottomed barges normally use transverse beams of Z section, 6 to 7 inches (15.3 to 17.8 centimeters) deep, carrying light channels or I-beams fore and aft to support a timber deck. A deck of this type can carry a bearing pressure of 0.5 ton (.45 metric ton) per square foot.

DESIGN OF SUPERSTRUCTURE

The superstructure of a bridge on barges may be assembled either by normal or by special means. Superstructures of normal bays consist of *double-single, triple-single, double-double,* or *triple-double* assembly of standard panel-bridge equipment. Normally, a floating-bay superstructure is a single-story assembly and a landing-bay superstructure is a double-story assembly.

Decking for a superstructure of normal bays consists of standard chess with 3-inch (7.6 centimeters) wear treads laid diagonally over the chess. Add angle irons to deck on landing bay to increase traction. When connecting posts are used to connect floating bays, transoms and junction chess cannot be used to fill gap between bays. Place cut stringers on the two transoms at the end of each bay, and place two thicknesses of 3- by 12-inch (7.6 by 30.5 centimeters) planks spiked together on top of the cut stringers (Figure 20-5, page 260). Wire planks in place to prevent shifting. When span junction posts are used to connect bays, fill gap between bays in normal manner, using transoms and junction chess. Where maximum road width is desired, ribbands can be eliminated by a 2- by 24-inch (5.1 by 61.1 centimeters) hub guard installed 6 inches (15.2 centimeters) above deck to protect panels.

Use special connecting posts to connect bays and provide articulation (Figure 20-6, page 260). These special connecting posts provide ample strength and allow development of full capacity of superstructure. Equal articulation above and below connecting pin provides unrestricted space for movement in the connection. Such connectors do not require restrictive linkages, guides, or maintenance. Combination special connecting posts can be

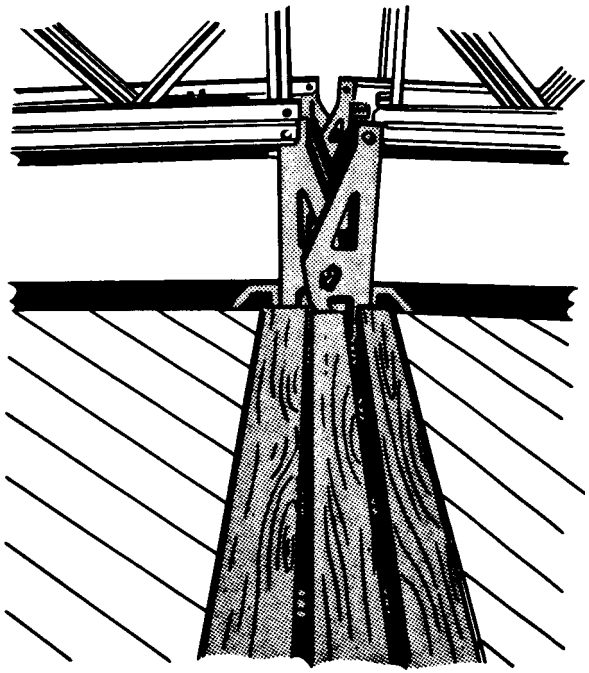


Figure 20-5 ***Planks on cut stringers for filling gap between bays when bays are connected with special connecting posts***

used in place of normal posts and also to connect two male or two female ends of panels.

Use special spans when barges are grounded or when passage of water traffic through the bridge is necessary. The capacities of the special spans are the same as the normal spans. However, their full capacity cannot be developed unless the suspending connection at each end is made strong enough. In addition, the weight of the lift span and draw span is limited by the lifting power and strength of the hoists, thus affecting the type of construction that can be used in these

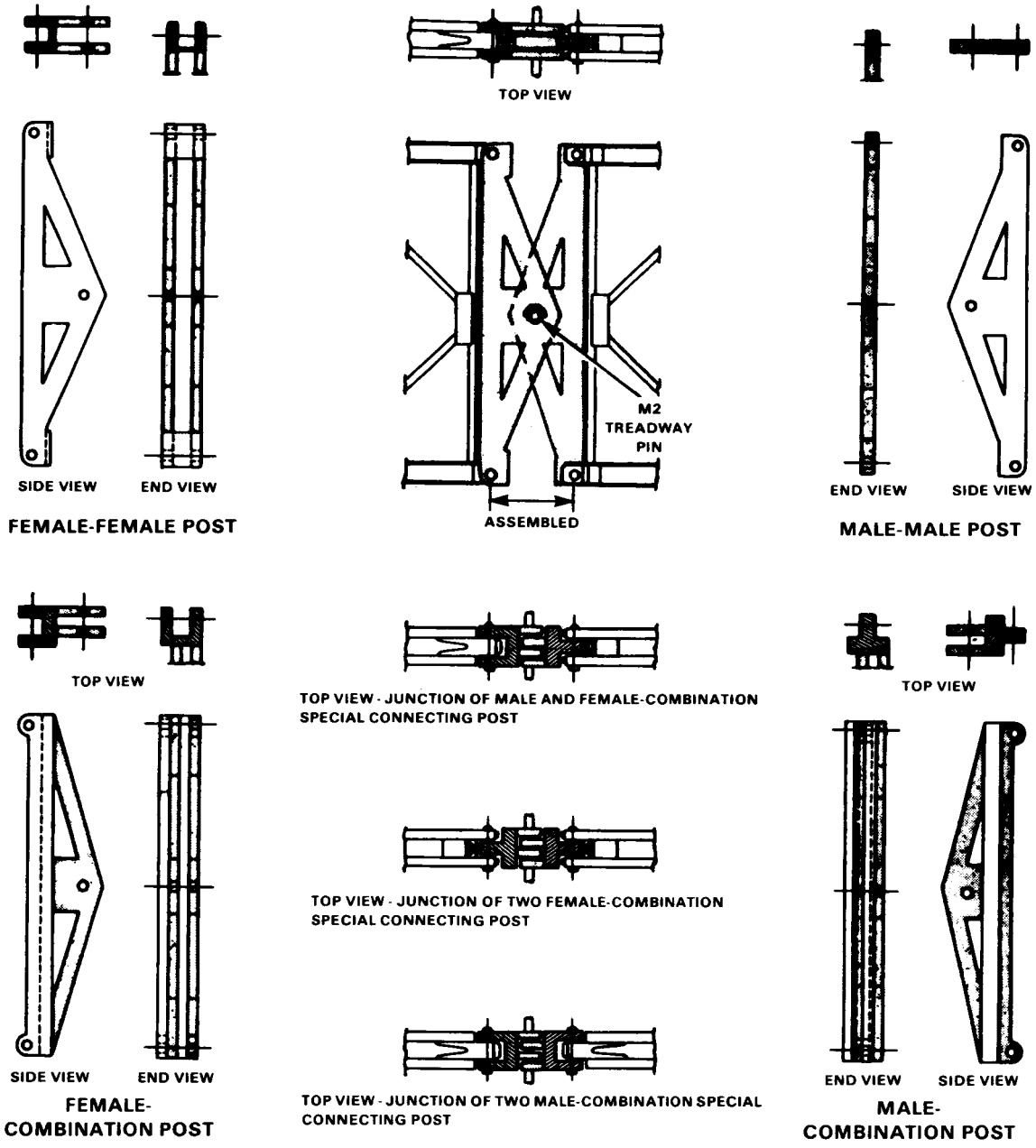


Figure 20-6 ***Special connecting posts***

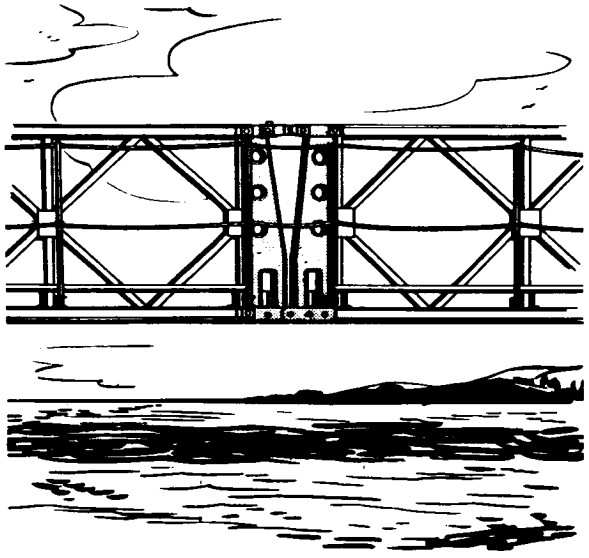


Figure 20-7 Use of span junction posts to suspend connecting span between bridge bays

spans. The three types of special spans used are connecting spans, lift spans, and draw spans. They are used as follows:

- Use the connecting span when barges are grounded or when special connecting posts are not used. It is a short span of *single-single* or *double-single* assembly suspended between two floating bays by span junction posts (Figure 20-7).

- Use the lift span only in short bridges where current is slow and there are no longitudinal forces in the bridge. When current is swift, pier heights can be increased to arch the bridge enough to pass water traffic under one of the center spans without use of a lift span. The lift span is *single-single* or *double-single* assembly 20 or 30 feet (6.1 or 9.4 meters) long. It is raised horizontally by block and tackle attached to span and to panel towers in adjacent bays.

- Use and restrictions of the draw span are the same as for the lift span. The draw span is a *single-single* or *double-single* assembly, usually 20 feet (6.1 meters) long (Figure 20-8, page 262). Hinge and suspend it to adjacent bays by span junction posts. Raise it at one end by block and tackle attached to span and a panel tower in one of the adjacent bays. If resulting gap is insufficient, use span of 40 feet (12.2 meters) and make cut at center of span. Then use towers with block and tackle at both ends and lift each half separately.

DESIGN OF BAYS

The barges and the superstructure together form sections called bays. These are designed as either floating or landing bays.

Floating bays are normally *double-single* assembly. However, for loads of 100 tons (9.1 metric tons) or more, unsupported span lengths are limited to 60 feet (18.3 meters) and assembly must be *triple-single.* The class is limited by type of assembly, by the span between centers of barges, and by the method used to support the superstructure on the barges. The class of floating bays is given in Table 20-1 (page 263). Normally, a barge near each end of a bay supports the superstructure. The superstructure must not overhang the barge at each end more than 15 feet (4.6 meters) from the centerline of the barge. However, a single barge can be used if it has ample width and capacity and the bay is stable under the load.

The type of assembly used in landing bays depends on length of span and on loads to be carried. A *triple-double* assembly is the heaviest type used. Maximum slope of the bay is 1 to 10 with adequate traction devices provided; without traction devices, slope is 1 to 21. Length of landing bay depends on conditions near shore. Use double landing bays where considerable change in water level is expected or when high banks are encountered. Assemble landing bays the same as normal panel bridges and use the same type of end support.

ADVANTAGES AND DISADVANTAGES

The panel bridge on barges has the following advantages:

- It does not use standard floats and pontons which may be needed at other sites.

- It allows long landing floating bays for use in tidal estuaries or rivers with high banks.

- It has large capacity barges which allow greater bridge capacity than standard military floating supports.

- It provides a stable bridge in swift currents.

1 DETAIL A
2 DETAIL C
3 SPRING WASHERS REST ON RIBBAND-BOLT SOCKETS AND MUST NOT TOUCH CHESS
4 BOLTS TIGHTENED DOWN ON PACKINGS TO LIFT RIBBANDS ABOVE CHESS
5 DETAIL B
6 SPAN JUNCTION POSTS
7 STRINGERS LASHED HERE
8 BOLT TIGHTENED DOWN
9 BOLT OMITTED
10 ENLARGE THIS ⅝" BEVEL TO 1"
11 CUT OFF BOTTOM MALE LUG
12 STRINGERS CUT AND LASHED TO TRANSOM
13 FEMALE SPAN JUNCTION POST-TOP LUG
14 MALE SPAN JUNCTION POST - TOP LUG

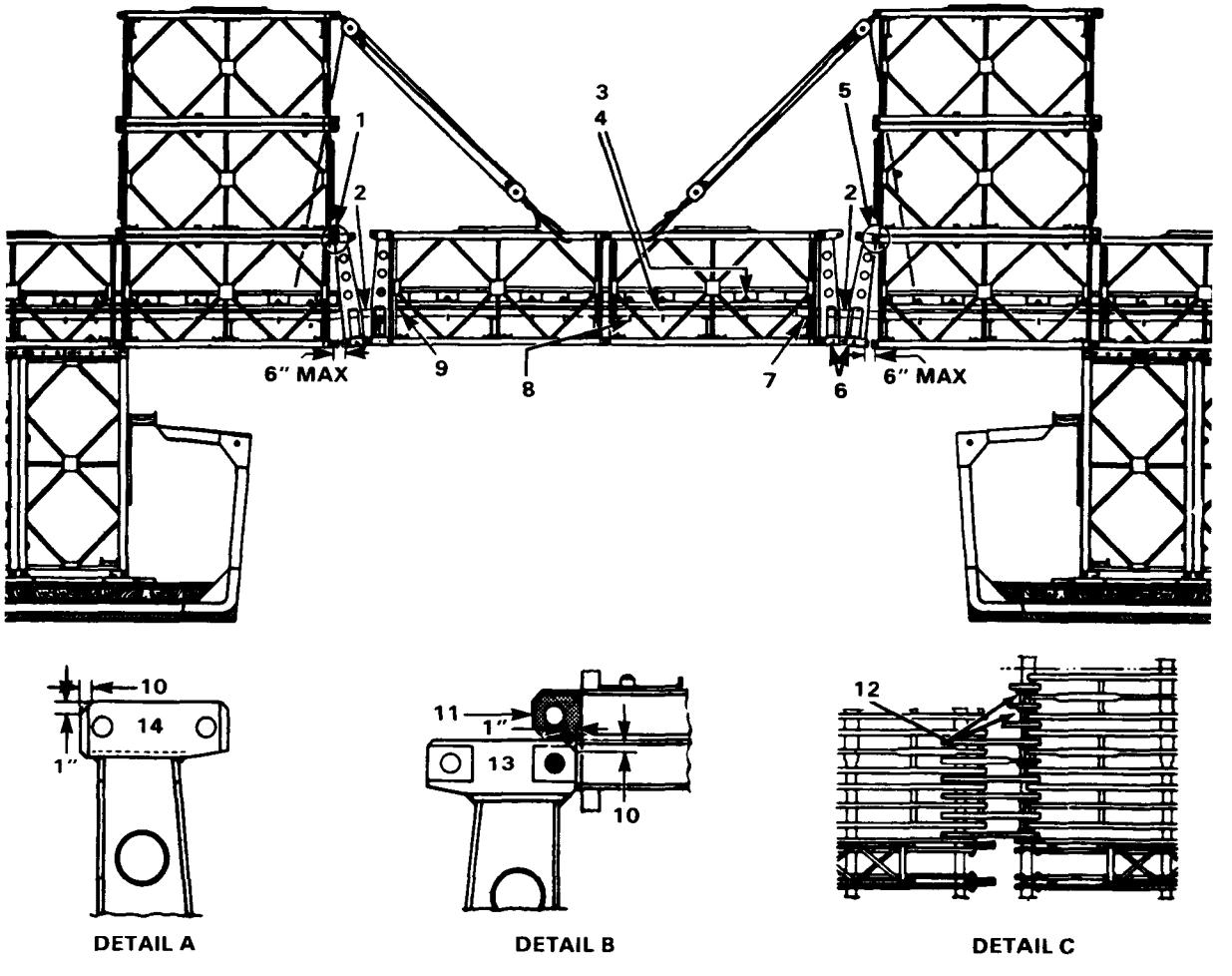


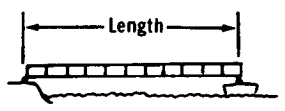
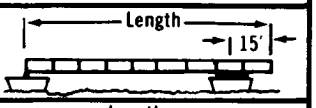
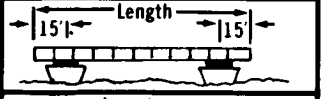
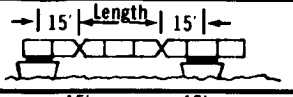
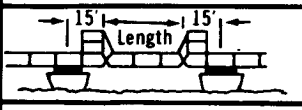
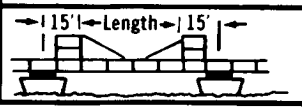
Figure 20-8 ***Panel-bridge draw span***

- It minimizes hazards of floating debris and ice.

The bridge has the following disadvantages:

- It uses barges which may be hard to obtain.
- It can be used only in navigable streams or waterways used by barges or vessels of the type and size necessary for use in the piers.
- It is not adaptable in combat areas because of equipment, material, labor, and time requirements.

Table 20-1 ***Class of bays and spans in panel bridge on barges***

TYPE OF BAY OR SPAN	TYPE OF CONSTRUCTION	LENGTH OF BAY OR SPAN (ft)														ILLUSTRATION
		20	30	40	50	60	70	80	90	100	110	120	130	140	150	
LANDING BAY	SS		40	32	28	26	22	18	13	10						
	DS		107	93	80	67	64	51	44	31	23	18	13	10		
	TS				113	100	88	80	62	52	40	34	23	18	13	
	DD							103	90	75	64	50	40	31	23	
	TD								106	93	80	70	57	48	40	
	DT										106	93	80	67	65	
	TT													105	93	
END FLOATING BAY	SS				36	30	26	22	18	15	11					
	DS				100	86	73	62	52	44	35	27	20	15	11	
	TS						106	94	81	68	56	45	35	27	20	
FLOATING BAY	SS					40	32	28	24	20	17	13	10			
	DS					107	93	80	67	57	48	40	31	23	18	
	TS							113	100	88	75	62	50	40	31	
CONNECTING SPAN	SS	28	24													
	DS	80	67													
	TS	113	100													
LIFT SPAN	SS	28	24													
	DS	80	67													
	TS	113	100													
DRAW SPAN	SS	28	24	20												
	DS	80	67	57												
	TS	113	100	88												

BARGE EQUIPMENT

Barges must be processed and their required equipment determined. Procure barges locally and then examine and rate them for capacity; determine the best point for use in the bridge; establish the type of barge loading (described later in this chapter) to be used; and sketch the construction needed to bring the bearings to exactly the elevation established for superstructure bearings.

After determining the type of barge loading. prepare a material estimate and an an equipment requirement list for each barge. Normally, steel beams, timber, blocking, wire rope, and miscellaneous bolts and fittings are needed. See Chapter 17 for equipment required if panel crib piers are used as supports on the barges.

PARTS FOR SUPERSTRUCTURE

Normal spans use fixed-span panel-bridge parts (Chapter 1). Connections between spans are made with special connecting posts that must be fabricated in the field (Figure 20-6) or by connecting spans using span junction posts supplied in the panel crib pier set (Chapter 17).

Special fittings to guide both the lift span and the draw span during raising and lowering must be made in the field. Block and tackle required are supplied in the freed-panel bridge set. Counterweights to aid in raising and lowering the span can be improvised. The lift span or the draw span, and the floating bays, are connected by span junction posts from the panel crib pier set.

The normal erection equipment supplied in the fixed-panel bridge set is sufficient to assemble the superstructure. Truck cranes aid the erection of the superstructure and the preparation of the barges. Acetylene torches, arc welders, chain falls, power and hand winches, diving equipment, and sea mules or power tugs with enough power to move floating bays into position should be available at the site.

SITE SELECTION

Tactical requirements determine the general area within which a site must be selected. The following factors should be carefully considered in choosing the site:

- There should be a road net close to the site over which equipment can be moved.

Roads and approaches should require as little preparation and construction as possible and should be straight and level for at least 150 feet (45.7 meters) before reaching the stream bank.

- Near-shore area should afford suitable sites along the shore for barge preparation and bay assembly.
- Banks should be reasonably steep and firm so that water gap will not change materially with water level. Banks high enough to allow launching of superstructure to barge piers are desirable.
- The site should be on a straight reach of the stream or estuary and free from cross currents that would exert a longitudinal force on the bridge. Water at bridge site should be deep enough to float barges at low water if no barges are to be grounded. Water at assembly sites should be deep enough to allow preparation of barges close to shore and launching of superstructure directly to barges. If barges can be grounded at low water, the stream bottom should be reasonably smooth and level. The stream should be free of obstruction at the assembly sites and bridge site.

SITE RECONNAISSANCE

After the general area has been determined, make a study of aerial and terrain maps to determine possible bridge sites along the stream within the specified area.

Direct aerial reconnaissance generally gives the following information on these bridge sites:

- Site relation to existing road net, with estimate of road construction required.
- Alignment of river at site and channel obstruction in the vicinity.
- Approximate height of banks to decide suitability for approaches and landing bays.
- Approximate width, shore to shore, of river, and length of bridge required.
- Location, relative to bridge site, of material storage, equipment, and work areas, and of barge site next to near shore for floating-bay assembly.
- Location of barges large enough to be examined later in detail by ground reconnaissance.
- Nature of open water route from barges to bridge site, noting and locating obstructions to navigation.
- Routes over existing road nets for transportation of bridge materials from dump or other sources to bridge site.
- Location of adjacent quarries and aggregate supplies.

Ground reconnaissance gives the following data:

- Width of river from bank to bank.
- Profile of approaches and streambed.
- Character of soil in approaches, banks, and streambed.
- Profiles of possible routes of approach and linking roads to existing road nets.
- Current velocity.
- High and low water data indicated *on* profile and rate of flood and ebb of tide, if possible.
- Sketch showing location and description of suitable material storage and work areas, downstream assembly area with profiles at possible shore barge preparation sites, and floating-span erection sites.
- Sketch of barges located in aerial reconnaissance.
- Routing on open water from assembly sites to bridge site, with description and location of obstacles and estimate of work necessary to clear passage.
- Information on location, quality, and quantity of nearest aggregate source.

SITE LAYOUT AND PREPARATION

Before actual construction, alignment and grade of roads and approaches must be determined. Plan and locate storage and assembly areas so as to ensure uninterrupted progression of work and avoid unnecessary handling. After determining location and layout of site, complete road work and approaches to expedite delivery of bridge material. At the same time, prepare landing-bay and floating-bay assembly areas.

WORKING PARTIES

To build bridges of 500 feet (152.4 meters) or more, assign an engineer combat or construction group of three battalions, two panel bridge companies, one light equipment company, and one harbor craft company. *For* shorter bridges, reductions in personnel can be made. Table 20-2 presents a suggested breakdown of tasks and troops required for constructing an 810-foot (246.9 meters) class 70 bridge in a moderate current. Approach road construction will need five company days.

Table 20-2 ***Tasks: breakdown of personnel building an 810-foot (246.9 meters) class 70 bridge***

TASKS	PERSONNEL
Abutment preparation	1 platoon
Landing-bay assembly	1 platoon
Floating-bay assembly	1 platoon
Movement and connection of bays	3 platoons per bank
Unloading of equipment	2 platoons per site
Anchorage	1 platoon

An example of how to distribute work parties is—

Assume bridge will consist of the following bays, proceeding from near to far bank:
- One 100-foot (30.4 meters) *double-double* variable-slope landing bay.
- One 100-foot (30.4 meters) *double-double* fixed-slope landing bay.
- One 80-foot (24.4 meters) *triple-single* end floating bay.
- One 40-foot (12.2 meters) *double-single* draw span.
- Three 100-foot (30.4 meters) *triple-single* floating bays.
- One 90-foot (27.4 meters) *triple-single* end floating bay.
- One 100-foot (30.4 meters) *double-double* landing bay.

Assume an engineer group of:
- *3* battalions.
- 2 panel bridge companies.
- 1 light equipment company.
- 1 harbor craft company.

One possible assignment of units to construct this bridge is as follows:

One battalion to construct:
- One 100-foot (30.4 meters) *double-double* variable-slope landing bay.
- One 100-foot (30.4 meters) *double-double* fixed-slope landing bay.
- One 80-foot (24.4 meters) *triple-single* end floating bay.
- One 100-foot (30.4 meters) *triple-single* floating bay.

One battalion to construct:
- One 100-foot (30.4 meters) *double-double* landing bay.
- One 90-foot (27.4 meters) *triple-single* end floating bay.
- 0ne 40-foot (12.2 meters) *double-single* draw span.
- Two 100-foot (30.4 meters) *triple-single* floating bays.

One battalion to:
- Prepare approach roads.
- Unload equipment.
- Prepare anchorages.

Two panel bridge companies to:
- Haul bridge equipment.

One harbor craft company to:
- Assist in maneuvering barges and bays.

One light equipment company to:
- Supply construction equipment with operators.

Time required for completion is approximately 6 days of daylight construction.

BARGE SELECTION

Before starting to build the bridge, barges must be chosen and positioned with care. In selecting barges, structural condition, capacity, shape, freeboard, type, and location of barge must all be considered. Examine and rate barges located on the reconnaissance. Barges which meet the requirements should be assigned a position in the bridge. Working

sketches and a plan of preparation for each barge are necessary to adapt it for use as a floating pier. Clear nonusable, easily unloaded material from the selected barges to help towing to barge preparation sites.

METHODS OF LOADING

Barges are adapted for use as piers by three methods. The method employed depends on the type of barge, *flat-bottomed* or *keeled*, and grounding conditions. The three methods of loading are gunwale loading, crib loading, and grillage loading.

Gunwale loading

As few barges are designed for gunwale loading, determine the strength of the barge ribs before using this method. Barges are normally built with a narrow deck running full length along each side of the hold. This deck space can be used for gunwale loading if the ribs and the deck are strong enough and the load is applied as nearly as possible over the ribs. Gunwale loading must not be applied to barges that will ground at low water unless the barge and the bay will remain level. If keel-type barges are used, the site of grounding should be in soft mud. Flat-bottomed barges should ground on flat sandy bed free from obstructions.

Use packing between the gunwale and the superstructure to distribute the load. The deck is normally cantilevered from the ribs and considerable load is placed on the ribs when the deck is loaded. The deck will probably have to be supported by struts from the barge floor to the edge of the deck or by

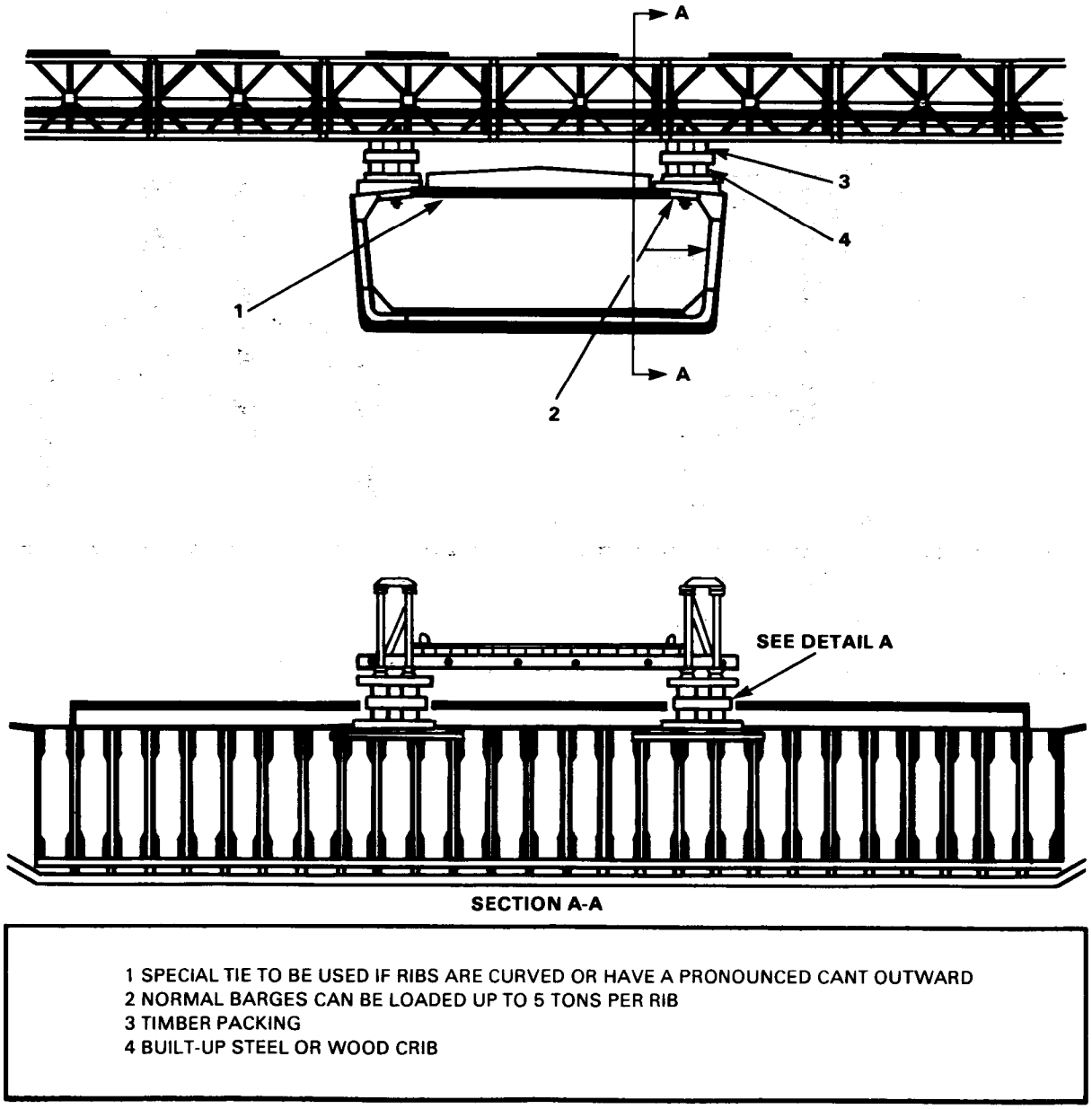

A
3
4
1
A
2
SEE DETAIL A
SECTION A-A
1 SPECIAL TIE TO BE USED IF RIBS ARE CURVED OR HAVE A PRONOUNCED CANT OUTWARD
2 NORMAL BARGES CAN BE LOADED UP TO 5 TONS PER RIB
3 TIMBER PACKING
4 BUILT-UP STEEL OR WOOD CRIB

Figure 20-9 ***Adapting barges for gunwale loading***

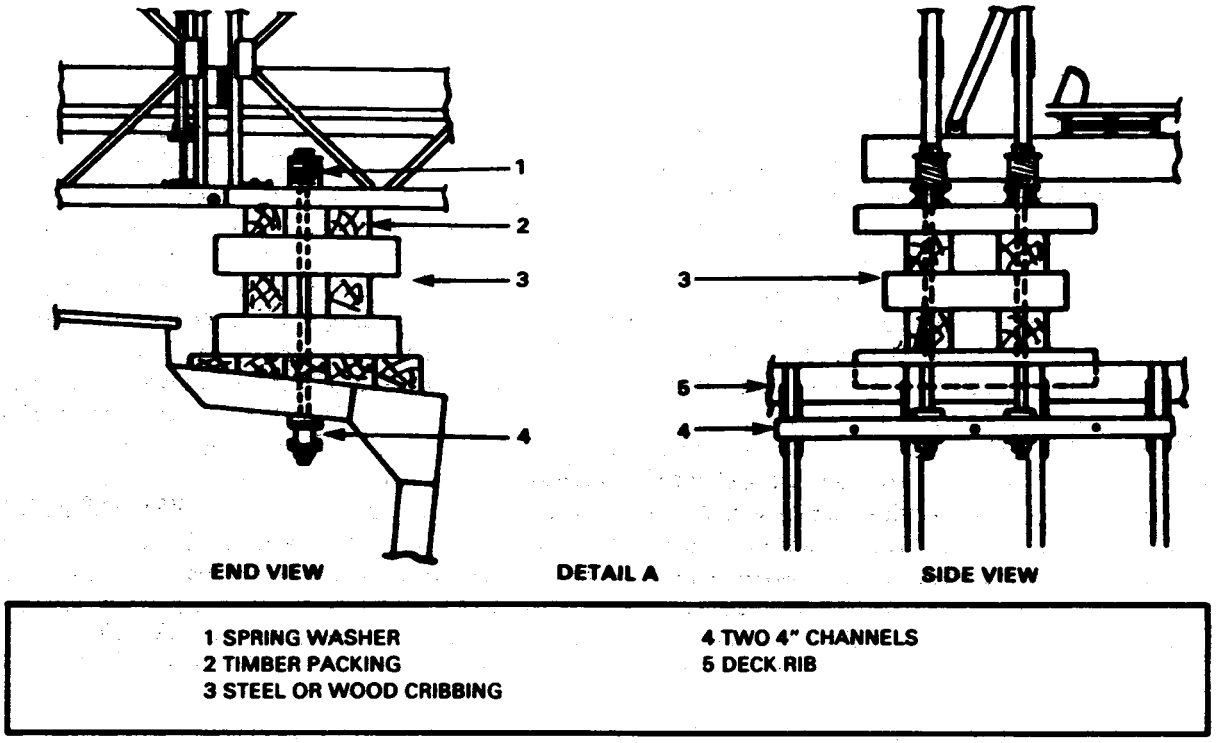


Figure 20-10 ***Recommended packing for adapting barges for gunwale loading***

packing the gunwales. The load on the gunwale can also be reduced by using a reinforcing bent built up from the floor in the center of the barge. Barges with curved ribs must be braced by rods between the gunwales or by struts from the reinforcing bent (Figures 20-9 and 20-10). If ribs are not curved and the length of rib from deck to keel does not exceed 10 feet, reinforcing of ribs is unnecessary.

Crib loading

Cribs made of panel-crib parts (Chapter 17) can be used to support the superstructure on the barge if the barge is unsuitable for gunwale loading or uneven grounding occurs Barge floors are designed to carry distributed loads, and grillage must be used under the cribs to ensure adequate distribution of the load. Crib loading requires more time for construction than gunwale loading but crib loading distributes the load to the floor of the barge, which is able to carry more load than the gunwales. Take special care to observe the behavior of cribs when the bridge is first loaded and during tidal changes. Mark the position of bearings so that movements can be determined. If careful observations are made, adjustments can be made in time to prevent serious movements and avoid the difficulty of repositioning barges and correcting misalignment of superstructurs. Secure anchorage of cribs prevents most of this difficulty.

There are two types of cribs: fixed, and rocking. Fixed cribs are used in both flat-bottomed and keeled barges that do not ground during low water. Use them also in keeled barges that ground during low water to prevent the barge from tipping. Connect fixed cribs rigidly to both the superstructure and the barge floor and guy both laterally and longitudinally to the gunwale. Details of assembly and methods of attaching the cribs to the superstructure and the barge floor are similar to those given in Chapter 17. Rocking cribs are used in flat-bottomed barges when uneven grounding occurs. Details of assembly and methods of making the rocking connections are given in Chapter 17. Clearance between the crib and the gunwale must be enough to permit the full articulation required. Determine the required clearance from the slope of the stream bottom where the grounding occurs. Guy rocking cribs fore and aft on the centerline of the barge as an added safeguard against movement. An expedient rocking crib is shown in Figures 20-11 and 20-12 (page 268). The crib is made to rock by removing one of the panel pins in the crib bearing before the barge has grounded.

Grillage loading

Use grillage loading when the barge is unsuitable for gunwale loading and the panel crib pier parts are unavailable. Build up grillages from the floor of the barge with steel or timber beams (Figure 20-13). When using

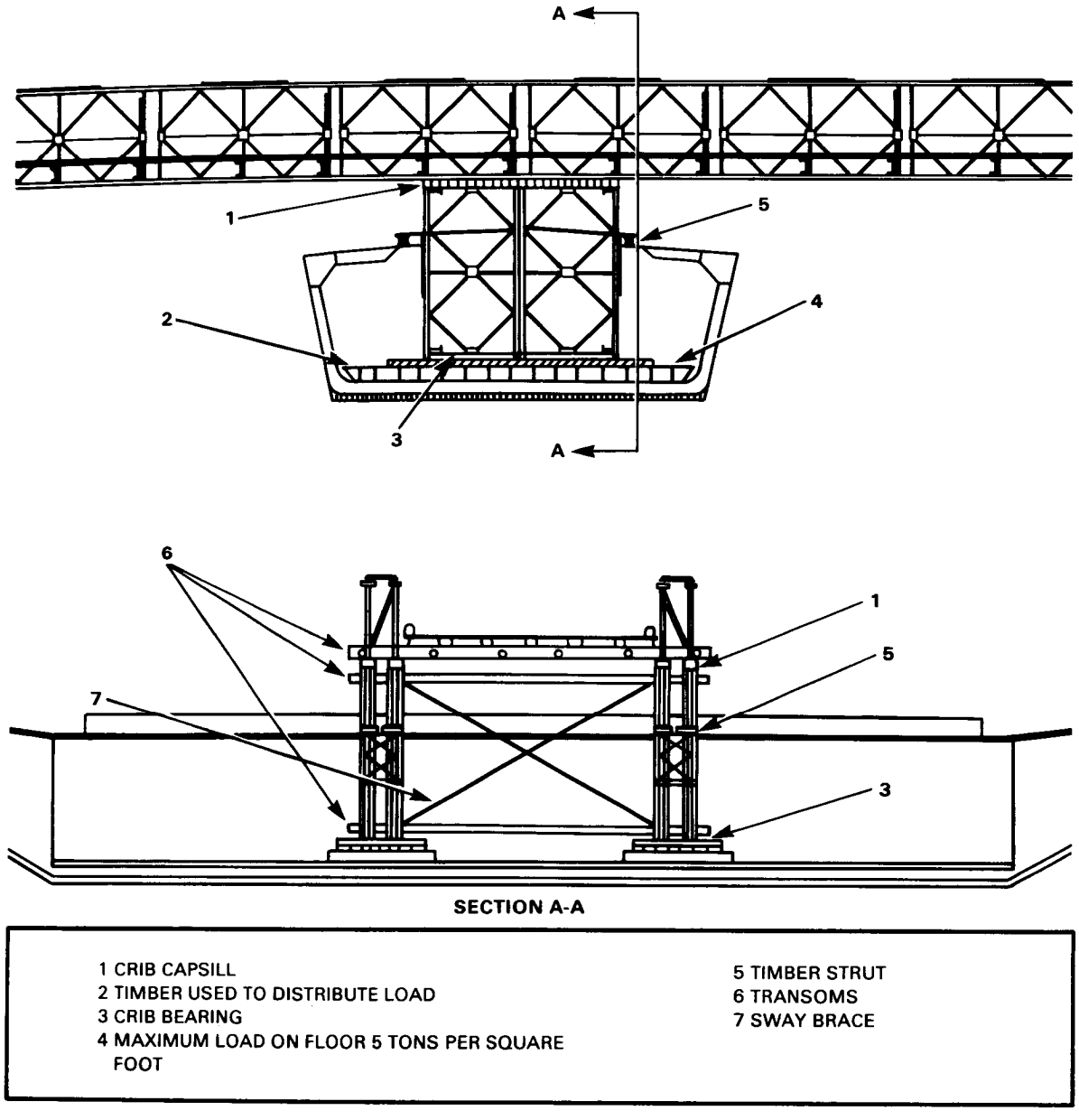


Figure 20-11 ***Expedient rocking crib, with*** *floating* ***barge using panel cribbing***

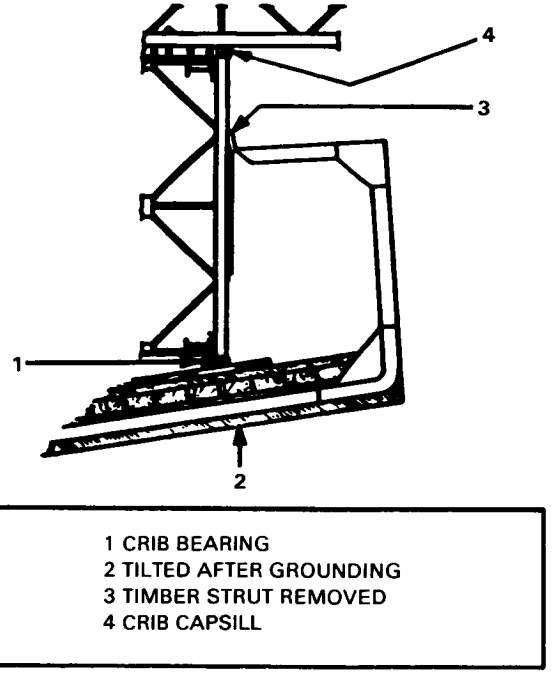


Figure 20-12 ***Expedient rocking crib, with*** *grounded* ***barge using panel cribbing***

grillage loading, take care in bracing and typing of grillage and in ensuring adequate distribution of the load on the floor of the barge.

PREPARATION OF PIERS

Both types of landing-bay pier are prepared in a similar manner (Figures 20-14 and 20-15). Since the intermediate landing-bay pier acts as a compensator in ramping, it always has a higher elevation than the landing-bay pier. Build up piers to the required elevation using I-beams, bolted down or welded to prevent sliding. When special connecting posts are not used to connect landing bays,

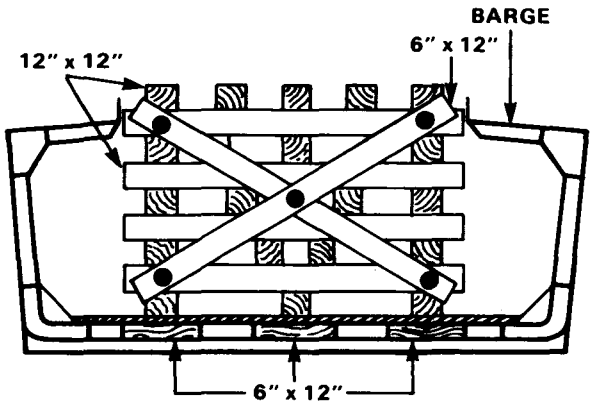


Figure 20-13 ***Section of timber grillage in barge***

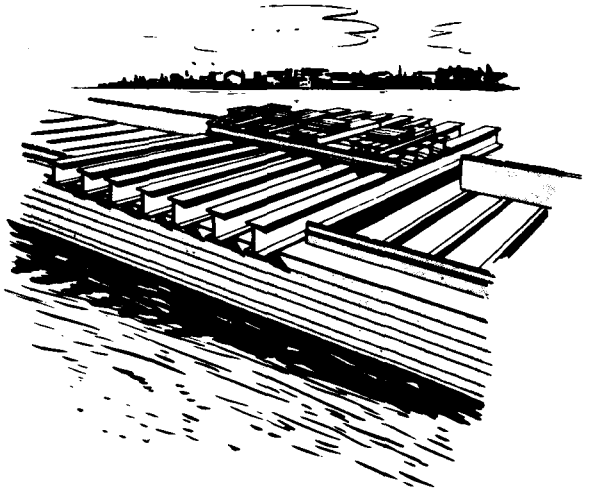


Figure 20-14 ***Preparation of intermediate landing-bay pier***

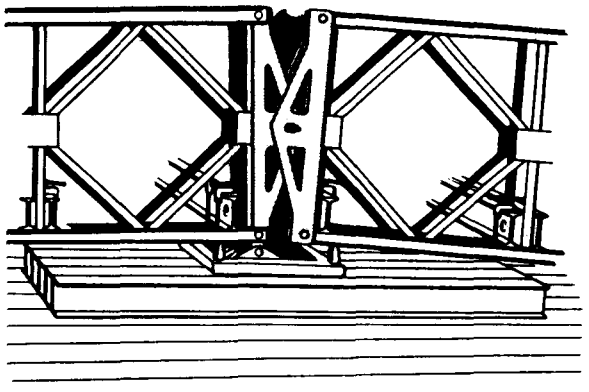


Figure 20-15 ***Bearing under special connecting post of variable landing bay***

weld base plates to the piers, and standard bearings to the plates, to support end posts.

Floating-bay piers are prepared similar to the landing-bay piers. Pair barges so those used in any pier have about the same freeboard. When the barges in the floating-bay piers have different freeboards, crib up the superstructure seats to the elevation of the superstructure seat on the barge with the greatest freeboard.

LANDING-BAY ASSEMBLY AND LAUNCHING

Use normal assembly methods given in Chapter 6 for assembling landing bays. Long spans are normally launched undecked.

Where the piers can be moved close to the bank, launch landing bays over rollers on the bank to the pier. Use the skeleton tail method (Chapter 18) where bank conditions prevent moving barges in close.

Where double landing bays are required, launch them as a continuous span, separately, or by use of construction barges, as follows:

- Assemble the two bays as a continuous span on the centerline of the bridge abutment. Launch this span over rollers placed on intermediate landing-bay pier onto cribbing on the landing-bay pier. Break the top chord over the intermediate pier by removing pins, and then jack the river end into final position. Remove bottom pins and pull back the variable-slope bay to permit installation of end fittings on the intermediate pier for both bays. Place abutment fittings in usual manner.
- When launching separately, launch the fixed-slope bay as described earlier, but place rollers on the intermediate pier instead of on the bank. Then launch the variable-slope bay.
- The fixed-slope bay can be assembled off site and launched to position on the intermediate floating-bay pier and a construction barge. Float the bay thus formed into position and connect to the end floating bay. Remove the construction barge. Then launch the variable-slope bay.

FLOATING-BAY ASSEMBLY AND LAUNCHING

Use methods given in Chapter 6 for assembling floating bays. Several methods of launching floating bays are as follows:

- Where barges can be placed close to the bank, launch the span over rollers on the bank to the off-bank barge. Then push out barge, permitting in-bank barge to be

positioned, and jack down the span into place on the in-bank barge. A construction barge can be placed adjacent to shore to use jacks on. This should have a lower freeboard than other barges.

- Where bank conditions permit, moor both barges side by side and launch the span over rollers on the in-bank barge to a position on the off-bank barge. Then jack down the span into position on the in-bank barge.

- When barges have wide beams, assemble sections of the bridge on each barge and then join to form bays; for long bays, partly flood surplus barges and float from under the superstructure.

- Cranes can place bridge equipment on barges, where it can be assembled on rollers. Spread barges to obtain proper bay length as superstructure is assembled.

CONNECTING BRIDGE SECTIONS

Bridge sections are linked by landing and floating bays. Landing bays have either special connecting posts or standard end posts, as follows:

- Special connecting posts are desirable for connecting all bays. The articulation provided is normally ample under all conditions. When both a fixed-slope landing bay and variable-slope landing bay are required, the special connecting post on the river end of the variable-slope landing bays have bearing blocks welded to the bottom. The posts are seated on bearings welded to base plates which are welded to the intermediate landing-bay pier grillage.

  Fix the shore end of the variable-slope landing bay with standard end posts mounted on bearings welded to base plates. The base plates rest on rollers set in an expedient box plate (Figure 20-16). This provides for lengthening and contraction of the bridge during changes in water level. The river and shore ends of the fixed-slope landing bay are suspended by treadway pins in the special connecting post.

- Where special connecting posts are not available for connecting landing bays, the bays can be seated on standard end posts on bearings. Rest the end posts on adjacent ends of variable-slope and fixed-slope landing bays on bearings welded to base plates mounted on the intermediate landing-bay pier grillage. Seat the river end of the fixed-slope landing bay on standard end-post bearings resting on base plates welded to the end floating-bay pier. Mount the shore end of the variable-slope landing bay as described for special connection posts.

Details of floating bay connection are as follows:

- Connection of floating bays is made easier by carefully constructing each bay to the same elevation. A ballast of water can be loaded for adjusting freeboard of the bay. A vehicle on the bay to be connected can be moved to aid in aligning connecting pinholes.

- Considerable tug power is required to move and handle bays into connecting position. Use both towing and pusher tugs to provide adequate control of the bays and prevent damage. Floating bays over 100 feet (30.5 meters) long are hard to tow and control.

- In connecting bays fitted with special connecting posts, it may be necessary to jack truss into place to get enough pinhole alignment for treadway pin.

- Carefully estimate maximum articulation and movement of junctions between bays during grounding. Too much articulation will cause undesirable changes of slope in the decking and may cause tilting or lifting of stringers or chess. If such a condition develops at grounding, minimize junction articulation by use of a connecting span between bays.

CONNECTING SPANS

Connecting spans are normally 20 to 30 feet (6.1 to 9.1 meters) long. Assemble each connecting span directly on a single construction barge at a correct elevation for connection in the bridge. Install proper male and female connecting posts at span ends to connect and suspend the span to girders of the adjacent bays in the bridge.

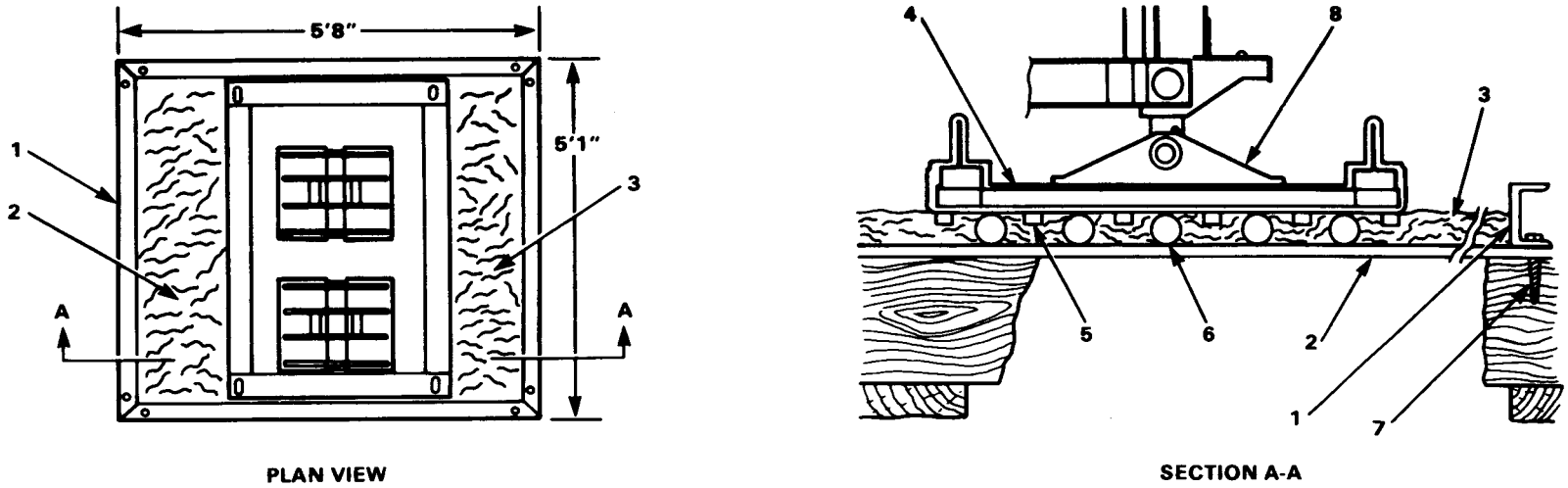


Figure 20-16 ***Shore sliding base plate in place***

LIFT SPANS

The lift span (Figures 20-3 and 20-17, pages 258 and 272) is normally assembled on a construction barge at a correct elevation for connection in the bridge. Determine length and lift of span by the beam and clearance of vessels to be passed through the bridge. To lift the span, build panel towers on the ends of adjacent floating bays. Install suitable connectors, guides, and lifting and counterbalancing devices on the towers for control and lifting of the lift span; install girders of adjacent floating bays for connection when span is lowered and in position to receive vehicular bridge traffic. Floating bays supporting the lift span must be designed to ensure a level bridge.

DRAW SPANS

The length of the span is determined by the beam of the vessels to be passed. Build towers on adjacent floating bays similar to lift span towers. Methods of building draw spans are as follows:

- Draw spans can be assembled on a construction barge to the correct elevation, and then moved and connected into the bridge.
- One-half the draw span can be added to each adjacent floating bay after tower erection at the bay-assembly site. The two floating bays can then be connected into the bridge, and the draw-span halves can then be connected.
- Draw spans can be built by assembly of single girders on the deck of adjacent spans. These girders can be launched by using tackle from towers to support free ends. Pin girders to bays and then deck them.

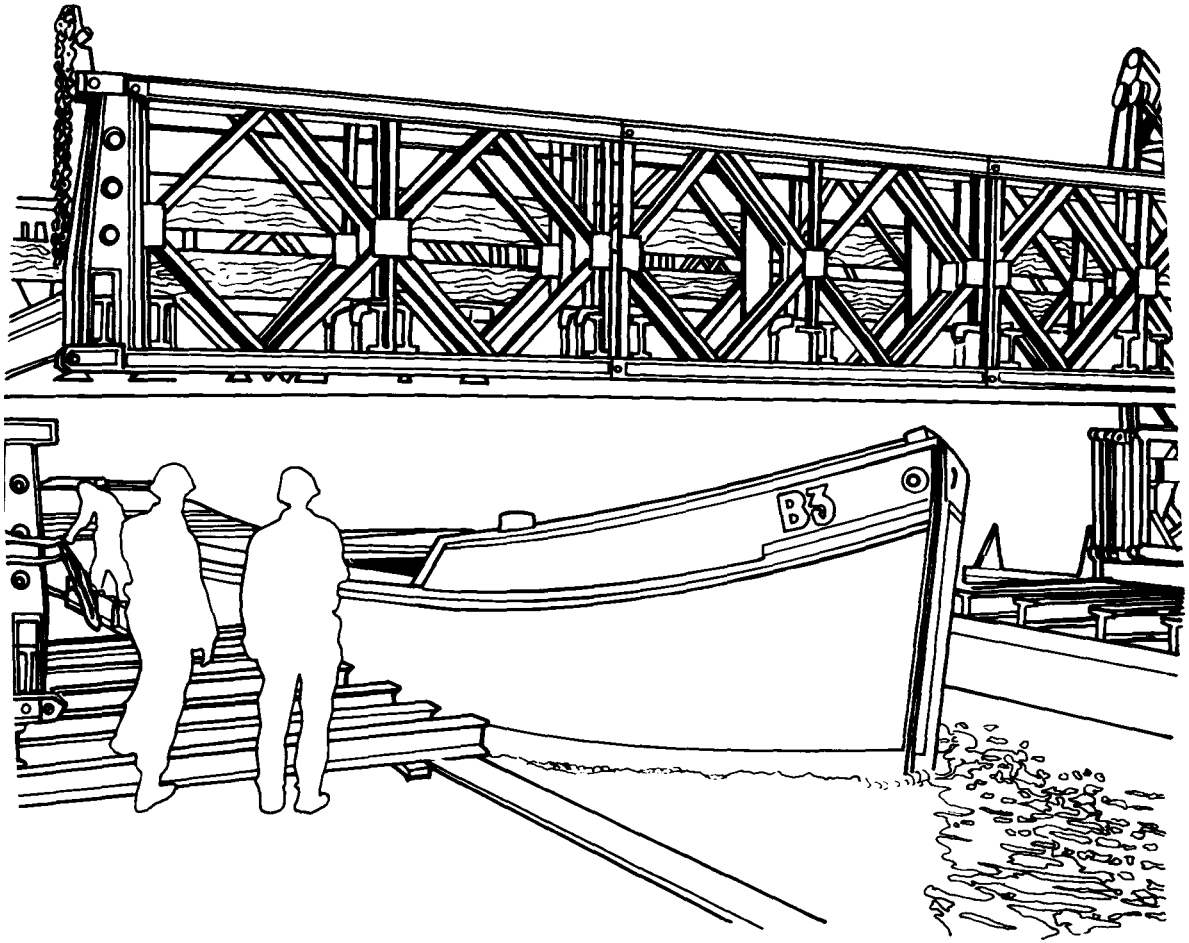


Figure 20-17 ***Lift span raised for river traffic***

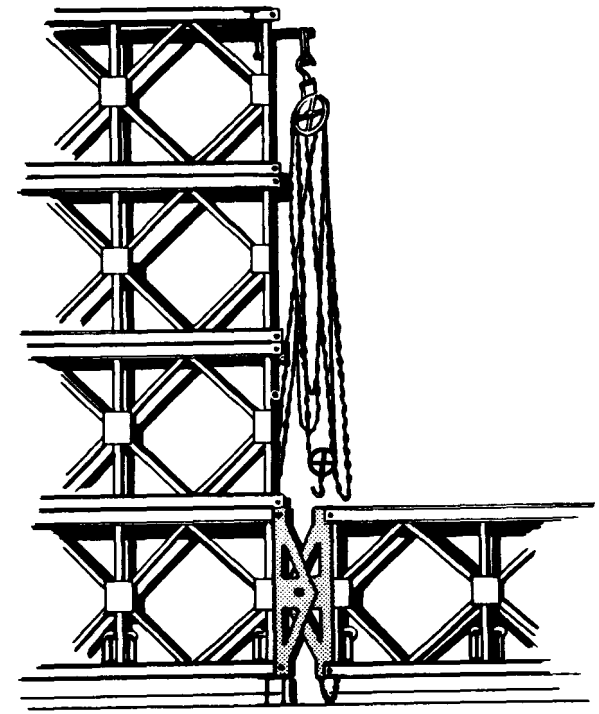


Figure 20-18 ***Panel tower and lift span connected and pinned for bridge traffic***

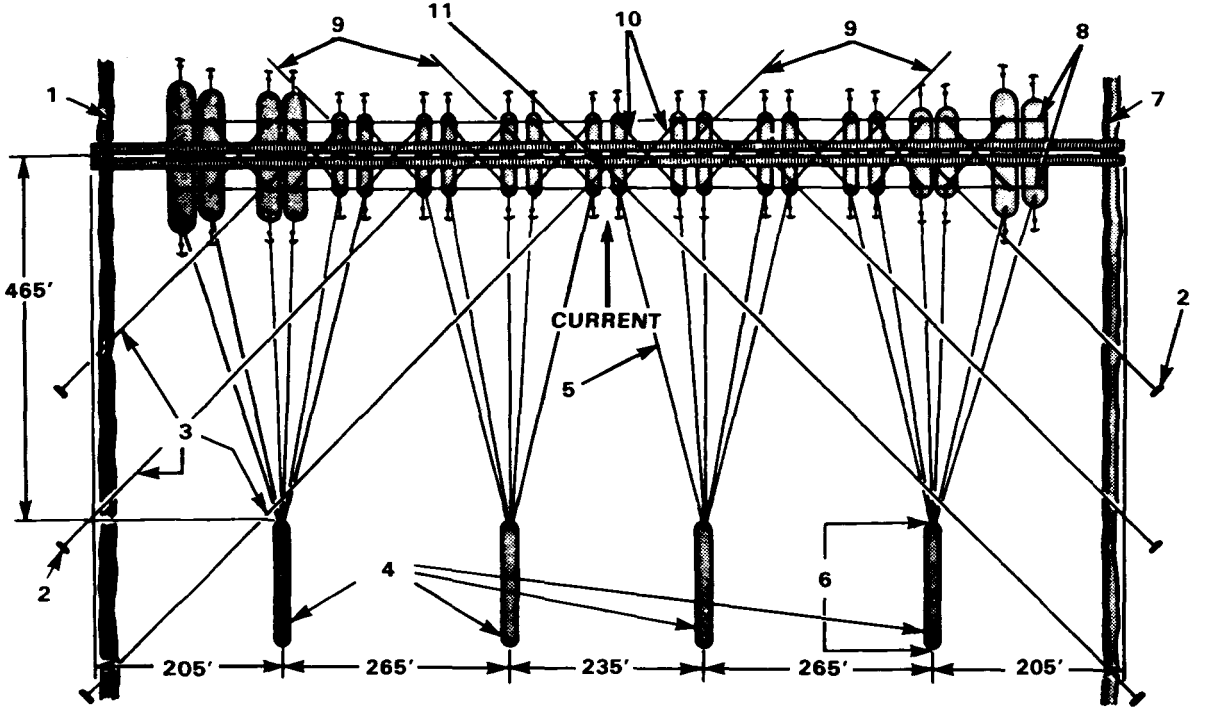
CONNECTING SPECIAL SPANS

When used to connect grounded bridge bays with special connecting posts, no special devices or maintenance is required after a connecting span is connected and suspended from girders of adjacent bay ends.

Connect a lift span to supporting adjacent bays by special connecting posts or span junction posts when positioned and pinned for vehicular bridge traffic. Provide a vertical guide system on the tower to control longitudinal movement of span during lifting of span to ensure proper pinhole alignment for reinsertion of connecting pins upon lowering (Figure 20-18).

Use the following procedure to connect a draw span:

1 Connect draw span to its adjacent floating girders with a suspension link or hinge mechanism. The link consists of span junction posts.



1 WEST BANK LINE	6 RED CHANNEL-MARKING BUOYS
2 DEADMAN	7 EAST BANK LINE
3 GUY LINES	8 LONGITUDINAL TIE CABLES
4 SUNKEN BARGES	9 TO DEADMAN
5 50-GALLON DRUM TO BE USED AS A BUOY-ATTACHED ANCHOR LINE 150' FROM SUNKEN BARGE	10 DIAGONAL CABLES FROM BOW TO STERN OF BARGES OF EACH BAY
	11 GUY LINES ATTACHED TO CONNECTING POST

Figure 20-19 ***Suggested anchor and guy-line systems*** *for a barge bridge*

2 Arrange the decking to allow for movement across junctions. Cut stringers as shown in Figure 20-8, with one end lashed down to the end transom of draw span.

3 Install a pair of span junction posts at the center of the draw span to ease procedure. The pins are readily removed when the weight of the draw span is taken on the tower tackles. In lifting draw span halves, raise one side until jaws are clear. Then lever panels sideways, if required, to allow simultaneous raising of the span halves without fouling.

ANCHORS AND ANCHOR LINES

The bridge is secured by anchors and guy lines (Figures 20-19 through 20-21, page 274) against the effects of wind and current.

To determine needed types of anchors, examine the stream bottom and compute the expected pull on anchor lines due to these conditions. Barges loaded with stone or metal can be sunk upstream of bridge to serve as anchors.

Anchor line pull equals the sum of pull due to effect of current on submerged portion of barge and effect of wind on exposed portion of barge and superstructure. The following formulas may be used to determine this pull:

Pull due to current:

Where
P_1 = A_1V^2/P_1
= **pull in pounds**
A_1 = **vertical cross section area below waterline at beam of barge in square feet**
v = **velocity of current in feet per second**

Pull due to wind:

On barge:

Where
P_2 = $2A_{2p}/P_2$
= **pull in pounds**
A_2 = **vertical cross section area above waterline at beam of barge in square feet**

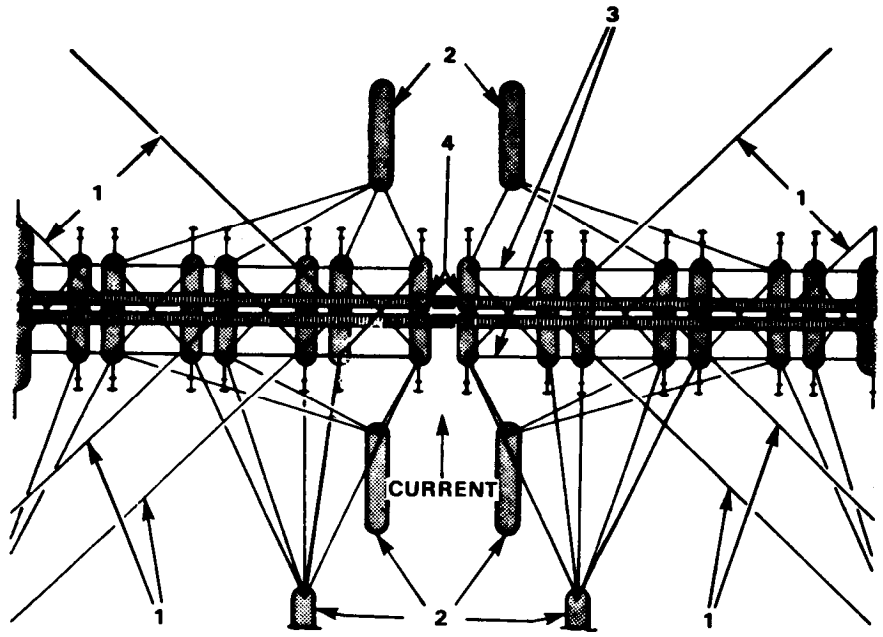


Figure 20-20 ***Suggested anchor and guy-line systems*** *modified for draw span*

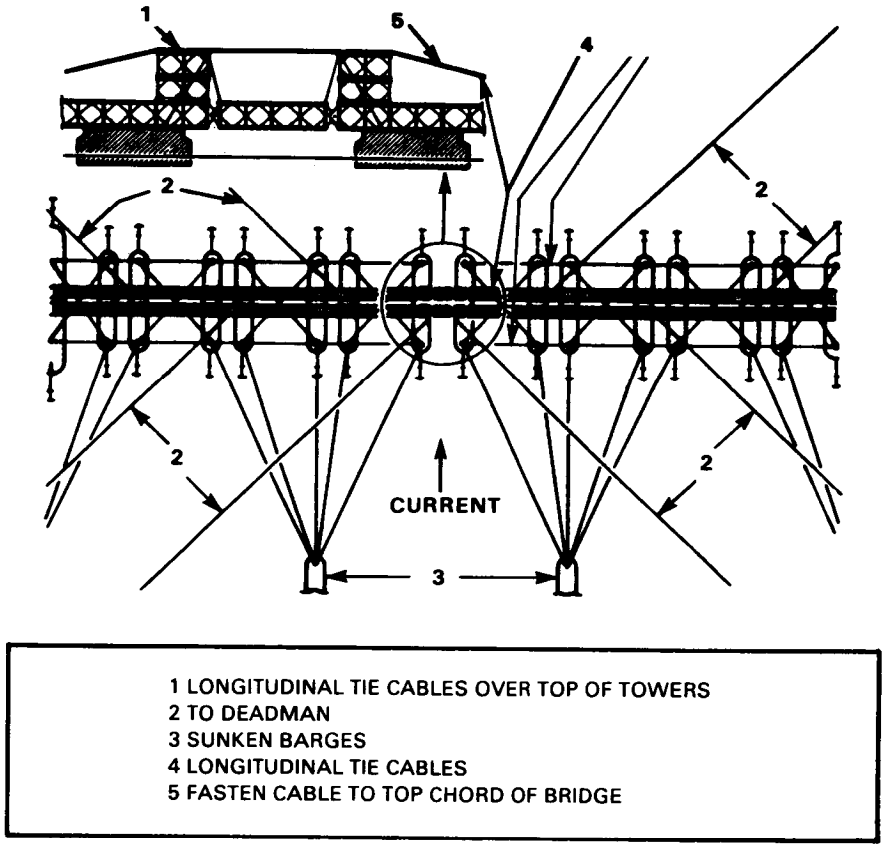


Figure 20-21 ***Suggested anchor and guy-line systems*** *modified for lift span*

p = pressure (pounds per square foot) for appropriate wind velocity in Table 20-3

On superstructure:

Where

$$P_3 = \frac{2000}{10\,(L_{1p1} + L_{2p2} + L_{3p3})}$$

P_3 = pull in pounds

L = length in feet of superstructure of a particular type (Table 20-3)

p = pressure (tons per 10-foot length) for a particular type superstructure, at an appropriate wind velocity (Table 20-3)

The pull due to current and wind is computed based on maximum expected conditions. Anchor lines should pull parallel to current.

Winches should be placed on barges to adjust tension in anchor lines.

*Table 20-3 **Wind pressures***

WIND PRESSURE (tons) PER 10-FOOT LENGTH OF SUPERSTRUCTURE				
TYPE OF CONSTRUCTION	WIND VELOCITY (mph) 40	60	80	100
SS	0.09	0.19	0.34	0.53
DS	0.10	0.24	0.41	0.65
TS	0.11	0.25	0.44	0.67
DD	0.18	0.40	0.72	1.12
TD	0.20	0.45	0.80	1.24
DT	0.28	0.64	1.13	1.77
TT	0.29	0.66	1.18	1.85
WIND PRESSURE ON VERTICAL SURFACE				
Wind velocity (mph)	40	60	80	100
Wind pressure (lb per sq ft)	5.1	11.5	20.5	32.0

GUY LINES

Use guy lines to anchor landing-bay piers to the riverbank. Place these lines at about a 45-degree angle to the bridge centerline. Longitudinal tie cables from stern to stern and bow to bow of each barge help to keep bridge aligned and to prevent longitudinal movement of parts of the bridge.

Special spans need modification of the anchor and guy system, as shown in Figures 20-20 and 20-21. In the lift span and draw span, the longitudinal tie cables must be broken to allow passage of river traffic. In lift spans, extra cables can be strung over the top of the towers to tie the bridge together over the gap. In draw spans, extra anchor barges may be sunk at each side of the gap to prevent the bridge from shifting when the span is open.

ANCHORAGE OF GROUNDING BARGES

Grounding barges may slide downhill, which can cause the landing bay to slide and dislodge the base plate and its bearings. Such slides can be avoided as follows:

- A barge which tends to slide down the bank when grounded must be suitably anchored to shore. Cables fastened to the bank can be passed under the barge to a connection on the off-bank gunwale of the barge. Use packings to prevent damage to the barge chines by the cables.

- When a barge slides on grounding, the resulting shift in the superstructure may cause the landing bay to slide beyond the limits allowed for bearings in the base plates. Rig tackle to prevent further movement until the bearings and base plates are reinstalled and secured in proper position.

MAINTENANCE DETAIL

Bridges on barges require round-the-clock maintenance arrangements. A detail of about one engineer combat company is needed to maintain an 800-foot (243.8 meters) panel bridge on a 24-hour-a-day basis. Normally, two squads each shift are enough to tighten bolts, check anchor cables, repair decking, and maintain adequate bridge signs. This leaves three squads to maintain approach roads, perform any major repairs, and man fireboat and standby tugs.

A duty officer should be at the bridge 24 hours a day. The officer must ensure that the following regulations are in force at all times:

- Communication is maintained between the ends of the bridge.

- A wrecker is on call to remove disabled vehicles from the bridge.

- Guides having thorough knowledge of standard hand signals are available to guide minimum-clearance vehicles across the bridge.

- Alignment of the bridge is constantly maintained.

- Tension in all anchor cables is kept uniform.

- Buffers are maintained between all anchor and guy cables that rub against metal.

- All cable connections are inspected every 12 hours.

- All pins, bolts, and clamps are inspected every 24 hours.

- All barges are inspected and bailed at least once every 24 hours.

- All base plates are inspected once every 24 hours.

- A source of electrical power is available for operation of trouble lights and tools.
- Immediate approach roads are maintained.
- All signs in the vicinity of the bridge are maintained.
- Traction strips and decking are maintained. All nailheads must be kept flush with surface.
- Tugs are stationed upstream and downstream at the bridge.
- A fireboat is available.

USE OF RAFTS

Multiple-lane rafts can be assembled from panel-bridge equipment supported on barges. Because of their ample freeboard and stability, such rafts can be used either as trail or as free ferries in swift currents and rough water.

Assembly

Normally, the raft superstructure is *double-single* or *triple-single* assembly. Details of assembly and launching, and of barge preparation, are given elsewhere in this chapter.

A typical barge raft used successfully is shown in Figure 20-22. This raft has a three-carriageway superstructure of four *double-single* girders 90 feet (27.4 meters) long on two 100-ton (91 metric tons) capacity Thames-type barges. This raft accommodates 12 vehicles having a combined weight of 120 tons (109.2 metric tons).

Inset position of barges in the raft as shown in Figure 20-22 is necessary, except in cases where the raft will be used in smooth water; otherwise, if the barges are placed near the ends of the raft in rough water, there is excessive stress in the connections between the barges and superstructure.

When the raft is towed in heavy seas, the decks may become awash, causing complete bays of decking to lift off the barges. To prevent this, use stringer clamps.

The superstructure must be secured to the barges to prevent fore-and-aft movement. Sway braces can be used for this purpose by fixing one end of the brace to a barge deck bollard or cleat and attaching the other end to a deck transom by means of two tie plates. The brace can then be tightened in the normal manner.

Use quays or docks to facilitate assembly and operation of a raft. It is preferable to operate between quays or docks of proper height for convenience in loading and unloading the raft. Where such site conditions exist, the height of the raft deck can be adjusted, within limits, by packing the superstructure girders up on cribs or by building a deck-type rather than a through-type raft. If quays or docks are unavailable, build ramps.

Operation

For continuous use of the raft as a ferry, install an upstream cable. Run bridle lines to winches mounted on the barges, allowing the raft to be swung at suitable angles to the current, and operate as a trail ferry.

When the raft is being grounded, the barges may assume different angles of slope. To relieve the superstructure of stresses, remove either all top or all bottom pins at the center-panel connections of the raft. This allows the two halves of the raft to articulate and conform to the lay of each barge. Close observation is required as the tide falls to determine whether the top or bottom pins are to be removed, and also the proper time to remove them.

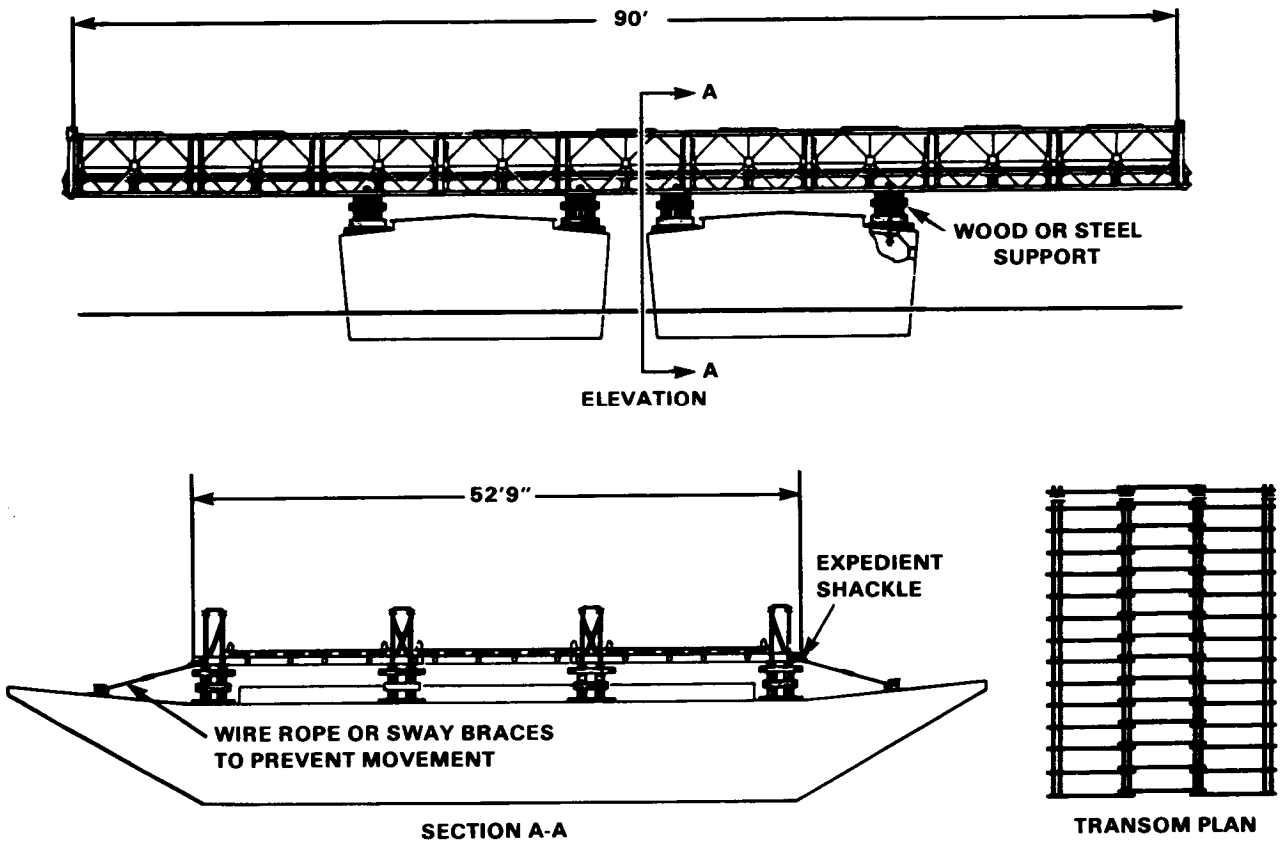


Figure 20-22 ***Typical barge raft***

CHAPTER 21

BRIDGE MAINTENANCE AND REPAIR

This chapter tells how to handle and store panel-bridge parts and equipment. It also tells how to repair damaged Bailey bridges, as well as how to dismantle and to replace them.

CARE OF PARTS AND EQUIPMENT

When storing and transporting panel-bridge parts, keep them clean and handle them as follows:

- For panels, grease jaws and inside of all holes. Panels are easily distorted by improper storage and handling. Whenever possible, store them in upright position resting on the long side. If it is necessary to store them horizontally for stability, do not stack more than 10 on a flat base. Stack on timber cribbing rather than on the ground.
- For bracing frame, rakers, and tie plates, grease conical dowels.
- For end posts, grease curved bearing surfaces and pinholes.
- For bearings, grease bar segments.
- For panel pins, grease shanks.
- For sway braces, grease threads and pins.
- For bolts, grease entire bolt.

Protect pieces of erection equipment, such as rollers, jacks, panel levers, pin extractors, and wrenches, by keeping them clean and lubricated to prevent rust.

Before launching abridge, lubricate bearings of plain and rocking rollers through grease fittings at both ends of shafts. Lubricate plain rollers as follows:

1. Clean out old grease and dirt around shaft at each end of both rollers.
2. Wedge rollers tight against outer bearings where grease fittings are located.
3. Add grease until it is forced out around shaft at inner bearings.
4. If no grease appears at inner bearing of either roller, disassemble and clean entire unit.
5. After reassembling the roller, repeat the second and third steps above.

BRIDGE MAINTENANCE DETAIL

For important bridges subject to enemy action, the maintenance party usually consists of the entire assembly crew. For routine repair work, however, the detail consists of only six soldiers. In rear areas, one traveling crew maintains all bridges in an assigned area or route. The maintenance detail—

- Checks bridge thoroughly after first 30 minutes of use and periodically thereafter for tightness of bracing bolts, chord bolts, transom clamps, and sway braces.
- Examines base plates and grillages periodically for uneven settlement and adds grill age when necessary.
- Checks tightness of cribbing under end transoms and ramps.
- Makes sure all panel-bridge pin retainers are in place.
- Lubricates all exposed threads and occasionally pours a small quantity of oil over each panel joint if the bridge is to remain in place for a long period or if it is to be dismantled in freezing weather.
- Repairs wearing surface on deck and ramps, and keeps stone and gravel off deck.
- Maintains immediate approaches and ditches.
- During heavy rainstorms, checks closely for erosion of bank seats, abutments, approaches, and drainage ditches.
- Replaces damaged end-post guards.

Table 21-1 ***Tools for routine bridge maintenance***

TOOLS	QUANTITY NEEDED
Wrench, ratchet (for double- and triple-story bridges only)	1
Wrench, socket, 1⅛"	2
Wrench, structural, 1⅛"	2
Wrench, structural, 1⅞"	1
Wrecking bar	1
Claw hammer	1
Carpenter's level	1
Hand crosscut saw	1
Sledge, 6-lb	1
Shovel, long-handled	1

Tools for routine maintenance work are listed in Table 21-1.

SPARE BRIDGE PARTS

Bridge supplies include about 10 to 25 percent spares for all bridge and nose parts except bearings, ramp pedestals, pickets, base plates, ramps, and ribbands. For replacing damaged parts of bridges subject to enemy fire, the spare parts in the bridge supply and additional parts covering the above exceptions are dispersed about the bridge site after completion of the bridge. Depending on the tactical situation, the spares may be increased up to 50 percent for forward-area bridges. Rear-area bridges require only enough spare deck parts and wear-tread planking to replace those worn or damaged by normal use.

For bridges subject to enemy action, complete erection equipment must be kept available at the site.

ASSESSMENT OF DAMAGE

The class of damaged bridge is found by comparing the residual strength of a damaged member with the actual maximum stress it must take according to its position in the bridge. Unit assembly of the panel bridge produces girders of uniform section throughout their entire length. Many individual panel members are therefore not stressed to full capacity when the bridge is under maximum load. Only chords of the center bays and vertical and diagonal members of the end bays are fully stressed. Any damage to these members decreases the bridge class in direct proportion. Lightly stressed verticals and diagonals of the center bays, and chords of the end bays, can sustain considerable damage without affecting the bridge class.

Since they can easily be replaced, the effect of damage to deck, transoms, sway braces, rakers, and bracing frames is not considered here.

RESIDUAL STRENGTH OF DAMAGED PANEL MEMBERS

Table 21-2 (page 280) gives the residual strength of panel vertical and diagonal members expressed as percent maximum capacity of the complete cross section. The figures apply to both tension and compression members.

Residual strength of damaged panel chords is given in Table 21-3 (page 268). The two channels of a panel chord act as one member. Damage to one channel is indicated in the left column of the table and damage to the other channel is shown in the top row. Combined result of damage to the two channels expressed as a percentage of the strength of the undamaged chord is found at the intersection of the appropriate column and row. In Tables 21-2 and 21-3, darkened portion indicates damage. When length of damage exceeds 15 inches, values must be reduced to 0.

SHEAR AND MOMENT DISTRIBUTION

To simplify calculations, shear and moment in single-story bridges are assumed to be taken equally by all trusses. Shear in a double-story bridge is taken equally by both stories except in end bays, where the bottom story takes 60 percent of the total shear. Top and bottom chords of double-story bridges provide all resistance to bending. Damage to intermediate chords can be disregarded if it does not reduce shear capacity of web-member connections.

Shear in a triple-story bridge is taken equally by all three stories except in end bays, as follows:

- Only bottom and middle stories resist shear when deck is in the bottom story.
- Only middle and top stories resist shear when deck is in the middle story.

Stress in top and bottom chords of triple-story bridges is about three times that in intermediate chords. However, to simplify calculations, it can be assumed that top and bottom chords provide all bending resistance.

Table 21-2 ***Residual strength of damaged*** *panel verticals* ***and*** *diagonals* ***in percent of maximum capacity of full section***

	1" DIAM HOLE					
100	85	70	50	25	5	0

Damage to intermediate chords causing loss of chord capacity up to 50 percent need not be considered, but cases of more extensive damage should be investigated and correlated with any damage in top or bottom chords of the same bay.

SHEAR AND MOMENT TABLE

Table A-16, Appendix A, gives maximum shear and bending moment in each bay of all spans of fixed-panel bridges expressed as percentages of maximum capacity. Dead-load shear and moment values (DL) show percentage of shear and moment capacity of each bay required to support dead weight of the bridge itself. Live-load values (LL) show percentage of shear and moment capacity of each bay required to support a tank load of the weight class of the bridge. Tank loads are placed at maximum eccentricity against one curb, increased 10 percent for impact, and moved along bridge to point of maximum effect for each bay.

Table 21-3 ***Residual strength of damaged*** *panel chords* ***in percent of maximum capacity of full section***

		DAMAGE TO NO 2 CHANNEL							
		1	2	3	4	5	6	7	8
DAMAGE TO NO 1 CHANNEL	1	100	50	60	60	40	55	55	5
	2	50	50	45	45	35	30	30	0
	3	60	45	40	60	30	55	25	0
	4	60	45	60	40	30	25	55	0
	5	40	35	30	30	40	15	15	0
	6	55	30	55	25	15	10	50	0
	7	55	30	25	55	15	50	10	0
	8	5	0	0	0	0	0	0	0

EVALUATION OF DAMAGE

The two main girders of a bridge are independent of each other and each must be capable of taking at least half the total bridge loads. If one girder is damaged it cannot be helped by any reserve capacity of the other.

Chords

The members at a given section of a bridge which have an identical function and act together must be considered as a unit. For example, each main girder of a *triple-double* bridge consists of three trusses. If a chord of one truss is completely severed, the remaining undamaged construction of that girder is *double-double* and capacity of the bridge is that of a *double-double* bridge of the same span. Moreover, if the damaged truss is incapable of supporting itself, the *double-double* capacity must be further reduced by half the weight in tons of the damaged truss. If the chord in one panel of a *single-single* bridge is completely severed, the capacity of the girder and bridge is reduced to zero.

Web members

Effects of damage to diagonals and verticals depend partly on the condition of adjacent members. When both diagonals at a vertical section of a panel are seriously damaged, shear strength of the panel at that section is reduced to 30 percent because shear is resisted only by bending in the chords. Any damage to the chords or other diagonals in the same half of the panel reduces the shear strength to zero. When one of the diagonals at a vertical section is completely severed, panel shear strength at the section is reduced to 50 percent. Each diagonal takes half the shear, one in compression and the other in tension. Residual shear capacities of panels with damaged verticals in percent of undamaged capacity are shown in Table 21-4.

Table 21-4 ***Residual shear capacity of panels with severed verticals in percent of undamaged capacity***

	LOCATION OF DAMAGE	STORY 1ST	2ND	3RD
END VERTICALS	Upper half	70	70	70
	Lower half	50*	70	70
	Both halves or through gusset	30*	30	30
CENTER VERTICALS	Upper half	80	80	80
	Lower half	0	80	80
	Both halves or through gusset	0	0	0
END VERTICALS AT END POSTS	Upper half	70	100	100
	Lower half	30	0	100
	Both halves or through gusset	30	0	100

*When both vertical at panel junction point are servered, these values are reduced to zero

Deformed members

When a member struck by flying metal is deformed and not severed, it must be watched as loads pass over the bridge. If further deformation takes place, it must be treated as if it were severed.

EXAMPLE:

Given:

A 90-foot *(27.4* meters) span, class 40 *double-single* bridge damaged as follows:

Case 1. In the third bay from one end, a flange of one channel in the bottom chord of one truss is missing.

Case 2. In the second bay from the end, a flange of one diagonal channel is severed.

Case 3. In the end bay, the center vertical of one panel is completely severed.

Required:

What is the load class of the damaged bridge without repair or reinforcement?

Solution:

Case 1. From Table 21-3, the residual strength of the damaged chord is 60 percent. As there are two trusses, the residual strength of the girder is—

$$\frac{100 + 60}{2} = 80 \text{ percent}$$

From Table A-16, Appendix A, bending stresses in the third bay are-

Dead load = 22
Live load = 67
Total: 89 percent

The damaged girder section is capable of taking on 80 percent of its original capacity. Therefore, the rated bridge capacity must be lowered to reduce stresses at this section from 89 to 80 percent. Dead load remains the same. Therefore, live load must be reduced by 9 percent.

Live load = 67 - 9
= 58 percent

Reduction in live load is approximately proportional to the lowering of the load class.

$$\text{New load class} = 40 \times \frac{58}{67}$$
$$= 34.6$$

Case 2. From Table 21-2, residual strength of the diagonal with one flange severed is 25 percent.

$$\text{Residual strength in panel} = \frac{25 + 100}{2}$$
$$= 62.5 \text{ percent}$$

Residual strength in truss
= 62.5 percent

$$\text{Residual strength in girder} = \frac{62.5 \text{ percent} + 100}{2}$$
$$= 81 \text{ percent}$$

From Table A-16, Appendix A, total shear in the second bay is 67 percent of maximum capacity, so this damage has no effect on the bridge class.

Case 3. The center vertical of one panel being completely severed reduces shear capacity in that panel to zero (Table 21-4) with one truss carrying zero percent shear and the other 100 percent shear. Therefore, the girder shear capacity is 50 percent. From Table A-16, Appendix A, shear in the end bay is—

Dead load = 21
Live load = 58
Total: 79 percent

Total load must therefore be reduced 29 percent to the girder shear capacity of 50 percent. With dead load remaining constant, allowable live load becomes—

58 - 29 = 29 percent.

$$\text{Load class} = \frac{29}{58} \times 40$$
$$= 20$$

Load class of the bridge is therefore determined by this damage to a center vertical in an end bay and must be lowered to class 20.

EXAMPLE:
Given:
The 90-foot, US class 40 *double-single* bridge of the example above has the chord of one truss in the third bay from one end completely severed.

Required:
What is the load class of the damaged bridge without repair or reinforcement if—

Case 1. The damaged truss is capable of supporting its own weight?

Case 2. The damaged truss is not capable of supporting its own weight?

Solution:
Case 1. We know from above that capacity is reduced to that of a *single-single* bridge of the same span or class 12.

Case 2. We also know from it that capacity of the corresponding *single-single* bridge must be further reduced by half the weight of the damaged truss. Table 1-2 shows the difference in weight of the two types of bridge bay as—

double-single **= 3.41 tons (3.1 metric tons)**
single-single **= 2.76 tons (2.5 metric tons)**
Difference: 0.65 tons (0.59 metric ton)

The damaged truss, therefore, weighs—

$$\frac{\text{9 bays x 0.65 ton}}{\text{2}} = \text{2.93 tons}$$

Capacity of the 90-foot *single-single* must be reduced by half this weight.

New class = 12 - 1.46
= 10.54 (class 10)

REPAIR METHODS

Damaged deck and bracing parts can be easily replaced with spares. However, replacing damaged panels is almost impossible without first relaunching bridge, which is difficult and time-consuming. If panel damage results in greater loss of capacity than can be tolerated, the bridge can be repaired by reinforcement or welding. Reinforcement is preferred because welding can cause serious added damage unless it is done in favorable conditions by experienced personnel.

REINFORCEMENT

Damaged panels and chords are reinforced in several ways.

Shear capacity lost by damage to panel vertical and diagonal members is restored by adding complete trusses or partial stories or by replacing damaged bays, as follows:

- Repair damaged *single-single* bridges by adding complete trusses.
- Use a complete truss when damage extends through several bays of double-truss bridges.
- Add a partial story when damage is confined to one or two bays on long spans. The partial story must extend two bays beyond both ends of damaged panels. In case of damage to first or second end bays, the partial story extends from end of bridge to two bays beyond the damaged panels.
- If the end bay of double or triple-story bridges is seriously damaged it must be replaced. Jack the bridge onto launching rollers and build a new bay at the undamaged end of bridge. Roll the new bay over the gap, dismantle the damaged bay, and lower the bridge onto its original bearings.
- If chord and web damage occur together, make repairs according to the above rules. Damage to exterior chords alone can be repaired with supplementary chords extending two bays on both sides of damaged panel. Modified bracing frames must be used with supplementary chord splices of top chords of double- and triple-truss bridges to maintain a continuous bracing system.

CLASS

The posted class of the bridge must be reduced by the dead weight of the partial story or supplementary chord.

The capacity of a girder reinforced with a complete truss is determined by the method for assessment of damage in terms of reduction of load class.

WELDING

All panel-bridge parts can be repaired by welding. Damaged parts which can be removed, however, preferably are replaced with spares. Repair work must be carefully done to prevent distortion and ensure proper fit of all parts.

Splice plates secured by fillet welds are more reliable than butt welding alone. Splice material should be mild steel plate about 50 percent greater in cross-sectional area than the damaged section of the member being repaired. Splice plates should be arranged to match as closely as possible the shape and position of the damaged section they replace. The minimum length, in inches, of a ¼-inch (.64 centimeters) fillet weld required on each end of a splice plate is 10 times the cross-sectional area of the plate in square inches (Figure 21-1, page 284).

¼-inch weld:
L (inches) = 10 x A (square inches)

If ⅜-inch fillet welds are used, the factor is 7 instead of 10.

⅜-inch weld:
L (inches) = 7 x A (square inches)

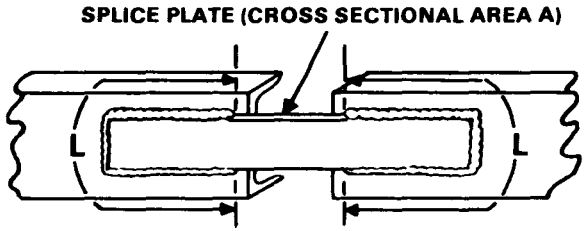


Figure 21-1 Effective length of weld on each end of splice plate

Before making welded repairs, clear the area around the fracture by cutting all jagged edges. Always do straightening cold.

Both mild- and high-tensile low-alloy steels of American parts can be repaired by either electric-arc or oxyacetylene welding. For electric-arc welding, the heavy-coated mild-steel shielded-arc electrode *(Lincoln Fleetweld No. 5 or equal),* included in the electric arc-welding set No. 1, is the most satisfactory. If welding is done by the oxyacetylene process, use a copper-coated mild-steel rod.

Cases of typical chord damage with correct repair are shown in Figure 21-2. Figure 21-3 shows typical damage repair of panel-web members. It is possible to use a standard set of strips in many cases, the more useful sizes being 3½ by ¼ by 12 inches (8.9 by .64 by 30.5 centimeters), and 1 ½ by ¼ by 12 inches (3.8 by .61 by 30.5 centimeters). The choice of strip sizes is determined by the requirement of using downhand welding wherever possible.

Removable parts can be repaired using the same general procedure as for panel members. Splice plates on transoms must not interfere with stringers or with positioning the transom seats on the girders. Welding of the lighter parts must be done carefully to prevent distortion and loss of interchangeability.

DISMANTLING OF BRIDGE

Panel bridges are temporary structures and should be replaced as soon as possible with semipermanent bridges. A panel bridge is dismantled in reverse of the order in which it was assembled. After dismantling, the panel-bridge parts are returned to the depot for reuse at another site.

The proper sequence of operations in dismantling a panel bridge is—

1 Take up ramps, jack up bridge, and place rocking rollers under each end and plain rollers on near-bank assembly site.

2 Remove end posts and assemble launching nose or counterweighted tail.

3 Pull bridge back on near-bank plain rollers.

4 Dismantle bridge and nose parts.

REPLACING OF BRIDGE

While the new bridge is being constructed, some provision must be made to allow traffic to cross the gap. This can be done by building a bypass, by building the new bridge directly under the panel bridge, or by building the new bridge alongside the panel bridge and relocating the approaches.

Traffic can be diverted over a nearby bypass, such as a temporary bridge or culvert, while the panel bridge is being dismantled and the new bridge is being built.

When a new two-lane bridge is being built, one lane is completed before the panel bridge is removed. This completed lane carries the traffic while the panel bridge is dismantled and the second lane is built.

When the new bridge is built directly under the panel bridge, traffic is interrupted only for a short time while the panel bridge is dismantled and the finishing touches are added to the new bridge deck and approaches. The new bridge can be either a timber trestle or a culvert with solid fill.

Timber trestle bridges can usually be constructed beneath the panel bridge and can be used as a working platform for driving piles or erecting trestle. Culverts can be constructed directly underneath the panel bridge and an earth fill built up to the underside of the panel bridge. This fill is compacted, if only a shallow fill, and surfaced after the panel bridge is removed.

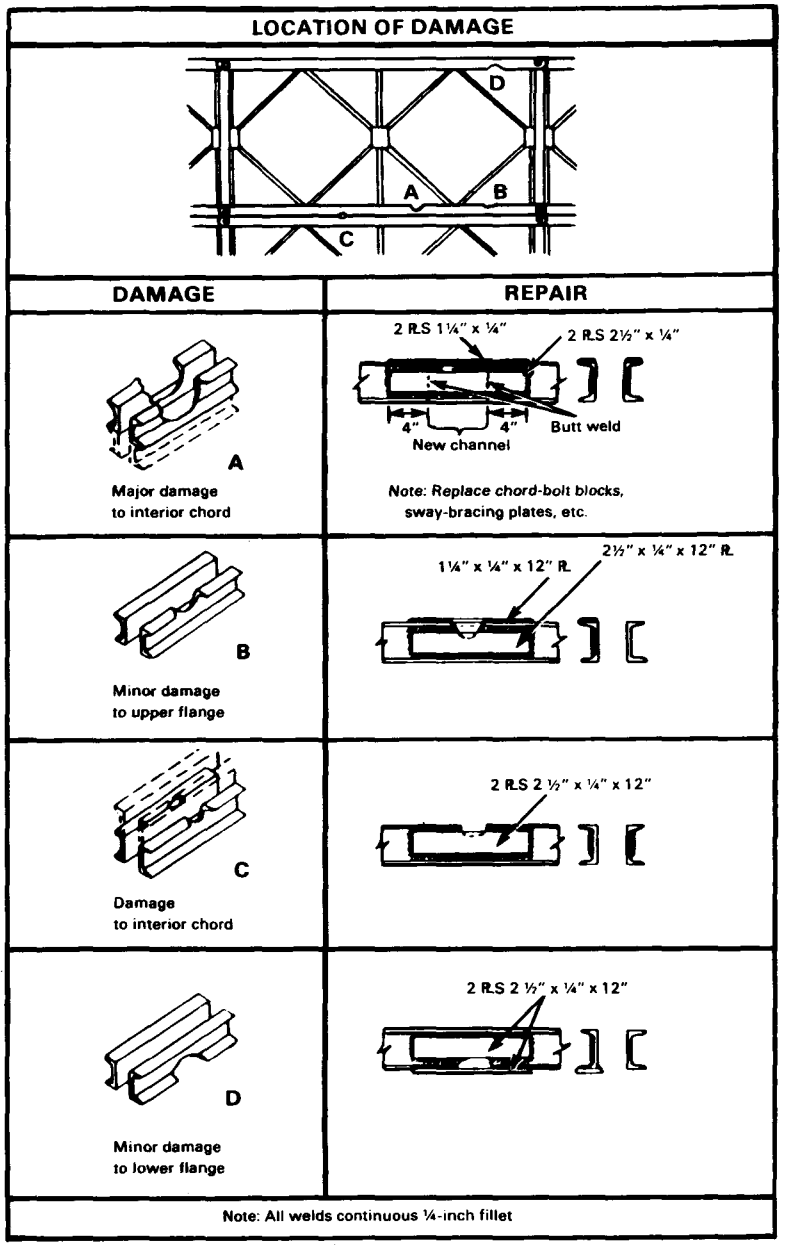


Figure 21-2 ***Typical welding repairs on*** *panel chords*

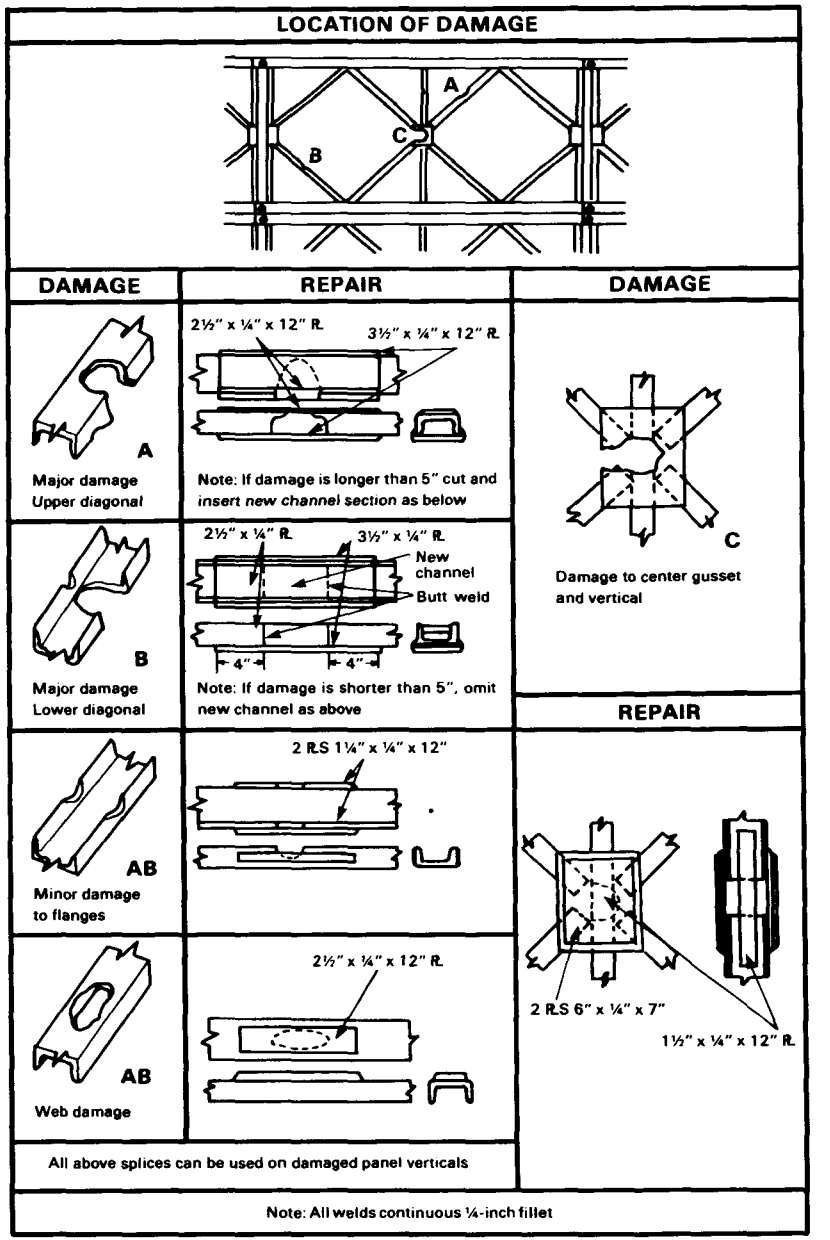


Figure 21-3 ***Typical welding repairs on*** *panel-web members*

CHAPTER 22
EXPEDIENT USES OF PANEL-BRIDGE EQUIPMENT

Panel bridge parts are often used in the field to build improvised structures. To aid in their proper use, the capacities of the parts are given here. In all cases, allowance must be made for impact and load-distribution factors. Table 22-1 (page 287) gives the strength of M2 panel-bridge parts, and Table 22-2 (page 289) gives the strength of panel-bridge erection equipment.

EXPEDIENT DECKING FOR PANEL BRIDGE

If stringers and chess are not available, an expedient deck can be laid on the transoms of a panel bridge. Timber or steel stringers with a wood floor can be used, or steel treadways can be laid on the transom.

EXPEDIENT WIDENING OF PANEL BRIDGE

The normal panel-bridge roadway width is 150 inches (381.8 centimeters). The roadway can be widened to accommodate wider vehicles. Some wide vehicles will have very little roadway clearance and require caution in entering the bridge; however, it has been found that the ribbands should be retained on the bridge for these wide vehicles. The ribbands help guide the vehicles across the bridge and prevent damage to the bridge trusses.

Certain non-US vehicles are more than 150 inches (381.8 centimeters) wide. By removing the ribbands, a roadway width of 165 inches (419.1 centimeters) may be obtained. Normal chess, used for a guard rail, should be bolted to the panels just below the top chord of the bottom story as protection against damaging the truss panels. To secure the chess to the panels, use carriage bolts with washers, with either steel plates or an added plank behind the truss to bolt through. Limiting the wear tread to the normal width between curbs will allow the curbs to be replaced promptly after the wide vehicles have crossed. Prompt replacement of these curbs is necessary to ensure the bridge's normal operating capacity. (A few crossings by tanks may quickly loosen the nails so that the treads must frequently be renailed. The guard rails may be left on the truss panels either with the widened roadway or with the normal bridge.)

The capacity of the widened bridge may vary some from the standard bridge due to the increased eccentricity possible in the widened bridge. Use normal capacities under caution restrictions at all times when the curbs are removed.

Table 22-1 ***Strength of M2 panel-bridge parts***

PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Bearing	(1) Concentric load	45	(1) 45 tons
Bolt, bracing	(2) Single shear (3) Tension	3.5 3.0	(2) 3.5 tons, 3.5 tons; (3) 3.0 tons, 3.0 tons
Bolt, chord	(4) Single shear (5) Tension	20 9.0	(4) 20 tons, 20 tons; (5) 9 tons, 9 tons
Brace, sway	(6) Tension	7.0	(6) 7 tons, 7 tons
Clamp, transom	(7) Maximum vertical clamp load when clamping transom in panel	2.0	(7) 2 tons
Link, launching-nose Mk II	(8) Compression or tension	62	(8) 62 tons, 62 tons, 62 tons, 62 tons
Panel as unit	(9) Moment of resistance to bending	380 ft-tons	(9) P, a, l, Pa/l (l-a) = 380 ft-tons
	(10) Shear across junction with both pins fitted	20	(10) 20 tons, 20 tons
	(11) End shear reaction with end post in single story (12) End shear without end post in single story	20 14	(11) 20 tons, 20 tons; (12) 14 tons, 14 tons

Table 22-1 ***Strength of M2 panel-bridge parts****—continued*

PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Panel as unit (continued)	(13) End-shear reaction with end post in double or triple story	34	(13) 34 tons, 34 tons
Panel chord	(14) Tension (15) Compression	80 65	(14) 80 tons, 65 tons, 65 tons; (15) 80 tons, 65 tons, 65 tons
	(16) Local bending, maximum load between panel-web members	10	(16) 10 tons
Panel verticals	(17) Loaded as a strut	14	(17) 14 tons, 14 tons, 14 tons
	Loaded parallel to long axis of panel: (18) Concentrated load at midpoint (19) Concentrated load	 20 4.5	(18) 20 tons; (19) 4.5 tons
	(20) Equal concentrated loads at midpoint and adjacent to both panel chords	14	(20) 14 tons

Table 22-1 ***Strength of M2 panel-bridge parts****—continued*

PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Panel junction with launching link Mk II	(21) Maximum shear	14	(21) 14 tons; 14 tons
	(22) Moment of resistance	380 ft-tons	(22) P, a, l; $\frac{Pa}{l}(l-a) = 380$ ft-tons
Pin, panel	(23) Double shear	160	(23) 80 tons, 160 tons, 80 tons
Post, end	(24) Compression	25	(24) 25 tons, 25 tons
	(25) Concentrated load on center when used as beam supported at pinholes	6.0	(25) 6 tons
Raker	(26) Tension or compression	6.0	(26) 6 tons, 6 tons, 6 tons, 6 tons
Ramp	(27) Moment of resistance per beam	8.0 ft-tons	(27) $\frac{Pa}{l}(l-a) =$ 8 ft-tons (ramp), 1.9 ft-tons (stringer); a, l
	(28) Moment of resistance as whole, when point loaded at center	16 ft-tons	
Stringer	(27) Moment of resistance per beam	1.9 ft-tons	(28) P, ½, l; $\frac{Pl}{4} =$ 16 ft-tons (ramp), 4.9 ft-tons (stringer)
	(28) Moment of resistance as whole, when point loaded at center	4.9 ft-tons	

Table 22-1 ***Strength of M2 panel-bridge parts****—continued*

PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Transom, M2 normal position	(29) Moment of resistance to bending	64 ft-tons 56 ft-tons (reduced section)	(29) a = 0 to .341 and .661 to 1.01; $\frac{Pa}{l}(l-a) = 56$ ft-tons; a = .341 to .661; $\frac{Pa}{l}(l-a) = 64$ ft-ton; P, a, l
	(30) Maximum vertical shear	19	(30) 19 tons, 19 tons
Transom, M2 lying on side	(31) Moment of resistance to bending	10.2 ft-tons 7.5 ft-tons (reduced section)	(31) a = 0 to .341 and .661 to 1.01; $\frac{Pa}{l}(l-a) = 7.5$ ft-tons; a = .341 to .661; $\frac{Pa}{l}(l-a) = 10.2$ ft-tons; P, a, l
	Maximum vertical shear: (32) Wide section	96	(32) 96 tons, 96 tons
	(33) Reduced section	42	(33) 42 tons, 42 tons

Table 22-2 ***Strength of panel-bridge erection equipment***

PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Jack, ratchet	(1) Load on head	15	(1) 15 tons
	(2) Load on toe	7.5	(2) 7.5 tons
Roller, plain	(3) Maximum load	10	(3) 10 tons
Roller, rocking	(4) Maximum load	30	(4) 30 tons

Table 22-3 ***Limiting spans for Bailey M2 bridges without end posts or additional panels***

SPAN (ft)	TYPE OF CONSTRUCTION: SS W	SS T	DS W	DS T	TS W	TS T
	CLASSES FOR NORMAL CROSSINGS					
20[1]	30	30				
30[1]	20		75[2]	65		
40[1]	17		50	50		
50[1]			40	40	75[2]	70
60[1]			35	35	60	60
70[1]			30	30	50	55
80[1]			30	30	45	50
90[1]			27	30	45	50
100[1]			25		40	45
110[3]			24		35	40
120[3]					30	35
130[3]					24	

[1]Maximum allowable shear for bridge without end posts is 14 tons per truss; an allowance for 15 percent impact and variable eccentricity is made for live load
[2]Classes 75 or above require four deck transoms per bay
[3]Moment governs, limits same as for bridge with end posts
Note:
W represents wheeled-load class
T represents tracked-load class

SPANS WITHOUT END POSTS

Single-story bridges can be built without end posts or bearings, the bridge resting on timber cribbing under the end vertical member of the end panels. However, this method of construction is not recommended unless absolutely necessary. When this is done, the transoms supporting the ends of the last bay of stringers must be supported by one of the following methods:

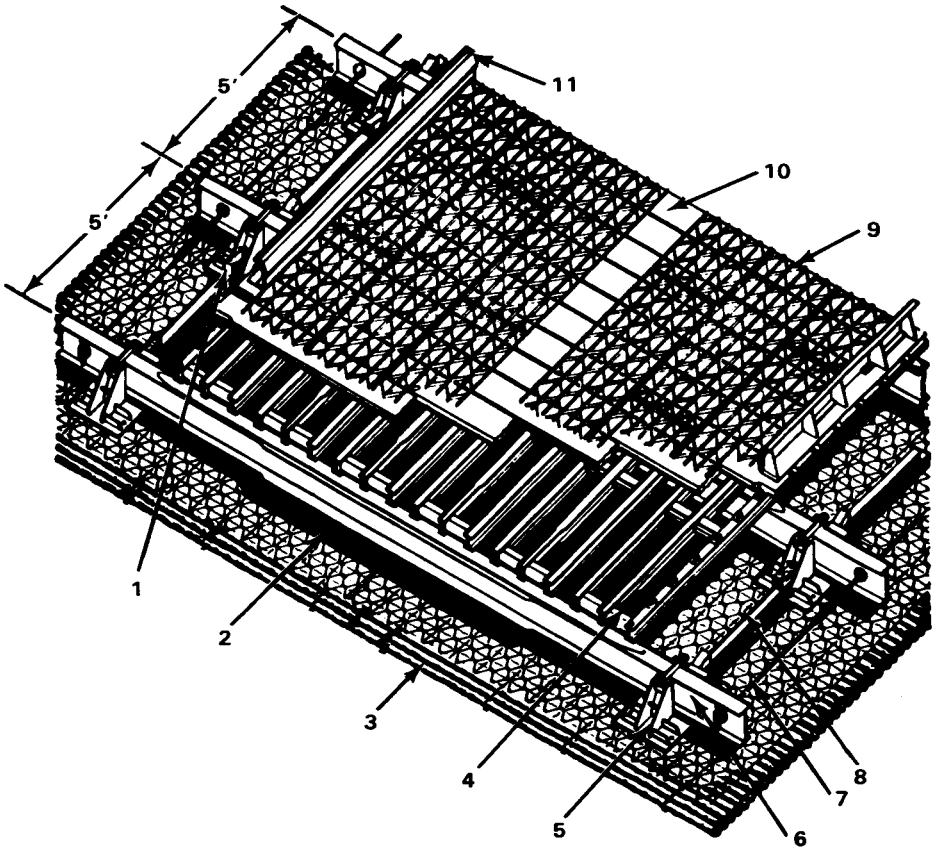
- When the end transom is not supported by trusses, place it outside the verticals of the panels and on grillage. Place an extra transom in the seating just inside the verticals of the end panel. Wedge blocking between these two transoms and lash them together. The ends of the stringers and ramps rest on and engage with the lugs of the end transom. Bolt bracing frames between the trusses at the end of the bridge. Table 22-3 lists the maximum spans that can be built with ends of the bridge supported in this way.
- When the end transom is supported by trusses, add an extra panel to the inner truss on each side of the bridge, and place a transom in this panel on the seating nearest the bridge proper. This transom supports the ends of the stringers and ramps. Place rakers on this transom and bracing frames between the trusses at the end of the bridge proper. Extend grillage under the end vertical 2 feet (61.1 centimeters) on each side of the panel joint. A bridge of this assembly can carry the same load as a corresponding bridge with its end transom not supported by trusses. If the extra panel is added to all the trusses, the bridge can carry the same load as a corresponding bridge with end posts. In both cases, place cribbing under the center of the end transom when loads are over 30 tons (27.3 metric tons).

CAUSEWAYS

Panel-bridge decking can be used to build an expedient causeway over the soft mud of a tidal riverbed. The causeway described here (Figure 22-1) has a capacity of 45 tons (41 metric tons) and can be used at all stages of tide to load heavy vehicles such as medium tanks on rafts. Its roadway can have a slope up to 1 in 5 and is not affected by heavy tracked vehicles that would normally cause a roadway of landing mats on corduroy material to break up. Use of panel bridge equipment or causeways is expensive in equipment, however, and should be controlled carefully to prevent a shortage of panel-bridge parts.

Preliminary work

The causeway consists of a normal panel-bridge deck of chess, ribband, and stringers supported on transoms set in ramp pedestals. To prevent scour and to distribute the load, rest the pedestals on a foundation of landing mats and sapling mats (chess paling or similar material). Place two pedestals under each transom and space the transoms 5 feet (1.5 meters) center to center. Use precut 4- by 3-inch (10.2 by 7.62 centimeters) timber spacers, or rakers with timber wedges, between the pedestals to take longitudinal thrust. Thread sway bracing through the outside holes in the transom webs and hold in place by bolts. Wire the button stringers to the transoms to prevent the decking from being lifted by the tide. Provide a nonskid surface by nailing down landing mat to the chess or wear treads. Use steel ribbands for curbing. Use holdfasts at each side of the causeway to anchor bays having a steep slope.



1 WOOD WEDGE	5 M2 RAMP PEDESTAL	9 IRVING GRID
2 LANDING MAT	6 M2 TRANSOM	10 CHESS
3 CHESS PALING	7 SWAY BRACE	11 STEEL RIBBAND
4 STRINGERS	8 RAKER	

Figure 22-1 ***Panel-bridge causeway***

Erection

About 100 man-hours are required to erect 100 feet (30.8 meters) of this causeway. If the precut timber spacers are used instead of rakers with wedges, erection time can be reduced 25 percent. Place spacers at the same time as the pedestals, before transoms are laid. Do not tighten sway braces until stringers have been placed.

The maintenance party keeps wedges, sway braces, and anchor lines tight.

Operation

At low tide, and at high tide during construction of the causeway, vehicles generally can be loaded and unloaded at the end of the causeway. The overhanging deck or adjust; able ramp of the raft rests on the end bay of the causeway so vehicles pass directly from the raft deck to the causeway. Where the causeway is begun at high tide, bays can be added at the rate of one bay in about 20 minutes as the tide lowers.

At high tide, the lower end of the completed causeway is submerged and rafts are loaded and unloaded at the higher bays. Use an adjustable landing ramp hinged to the raft to bridge the gap between the causeway and shore end of the raft. The shoreward ponton can be grounded on the submerged causeway, but care must be taken to position the raft so the water is deep enough to permit maximum displacement when the shoreward ponton grounds.

PANEL BOX ANCHORS

An expedient heavy rubble box anchor can be made from four panels welded into a box with heavy wire net and filled with rock. Completely filled with rock, the anchor weighs about 10 tons. Heavy anchors of this type are used to anchor heavy floating bridges in swift currents and in streambeds in which the standard anchor will not hold.

OTHER EXPEDIENT USES

Panel-bridge parts can be used to build gantries (Figure 22-2), anchor-cable towers, high-line towers, towers for suspension bridges (Figure 22-3), truck-loading traps, and other structures when building materials are not available. Angles and I-beams can be salvaged from damaged panel-bridge parts to be used for expedient construction.

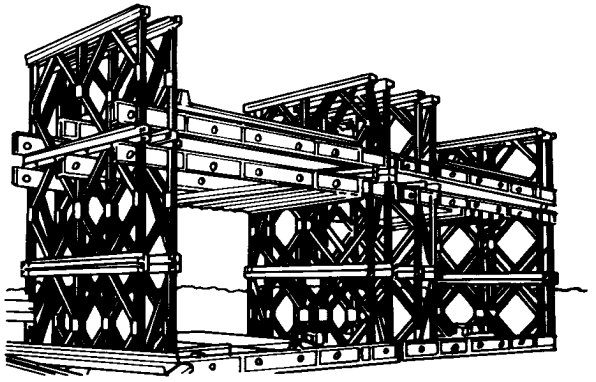


Figure 22-2 ***Constructing a ship-building gantry from panel-bridge parts***

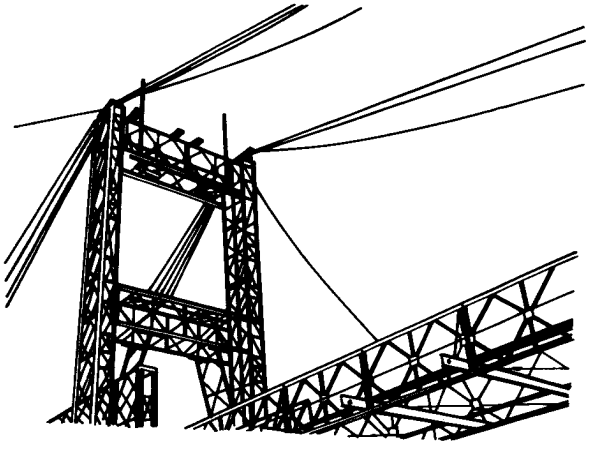


Figure 22-3 ***Bailey suspension-bridge tower***

CHAPTER 23

DEMOLITION OF BRIDGE AND PARTS

The success of these demolition methods depends on the use of a uniform procedure by all units in the theater. All ranks must be impressed with the importance of following the principles stated in this chapter. The destruction must prevent both enemy use of the bridge as a unit and use of its parts for normal or improvised construction.

ORDER AND METHODS OF DESTRUCTION

To prevent use of existing bridge, cut tresses so bridge drops into gap, and destroy abutments. To prevent reconstruction of a complete bridge, destroy one essential component not easily replaced or improvised. This component must be the same throughout the theater so replacements cannot be obtained from other sectors. The panel is the only component fulfilling these conditions. Always destroy all panels first. To make a panel useless, remove or distort female lug in lower or tension chord. Destruction of both female lugs is unnecessary.

Also destroy certain other components, such as transoms and decking, useful to the enemy for improvised bridging. Destroy components such as stringers, ramps, jacks, rollers, and erection tools only if time allows and explosives are available. Because the relative importance of these components varies considerably, follow the order of destruction given just below.

After the bridge is collapsed and the abutments destroyed, and if time permits, destroy individual components in the order used for destroying stacked equipment female lugs in lower chord of all panels; transoms and panels (Figures 23-4 and 23-5, pages 295 and 296); chess; stringers and ramps; jacks, rollers, and erection tools; and remaining small parts.

DESTRUCTION OF BRIDGE

Cut bridge in one or more places by cutting panels on each side of the bridge and sway braces in the same bay (Figure 23-l). Stagger the line of cut through the panels (inset, Figure 23-l). Otherwise the top chords may jam and prevent the bridge from dropping. In double or triple-story bridges, increase the

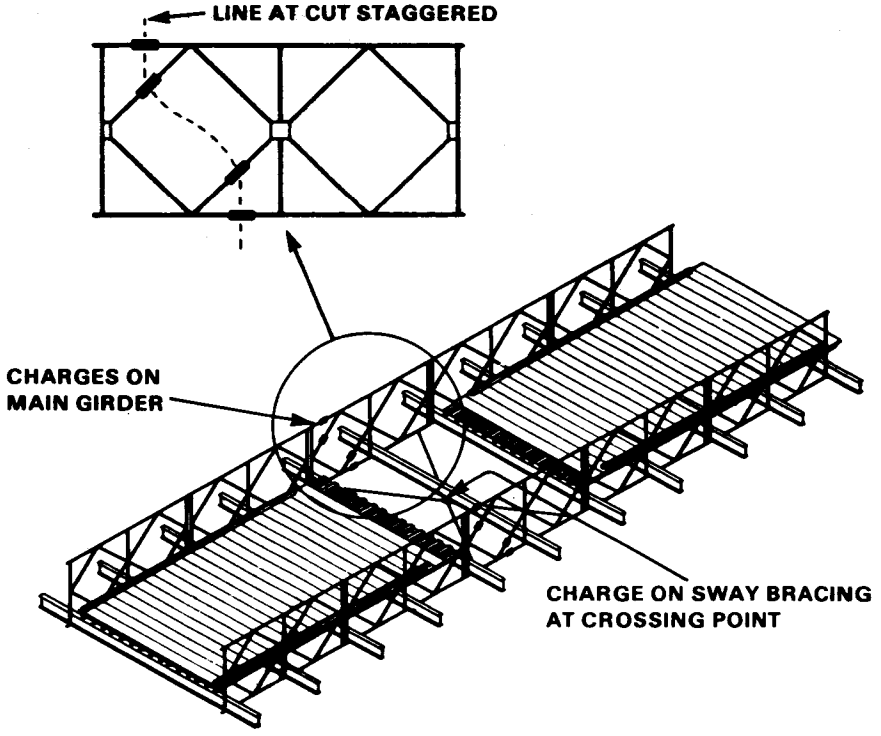


Figure 23-1 ***Destruction of assembled bridge, with placement of charges to collapse span***

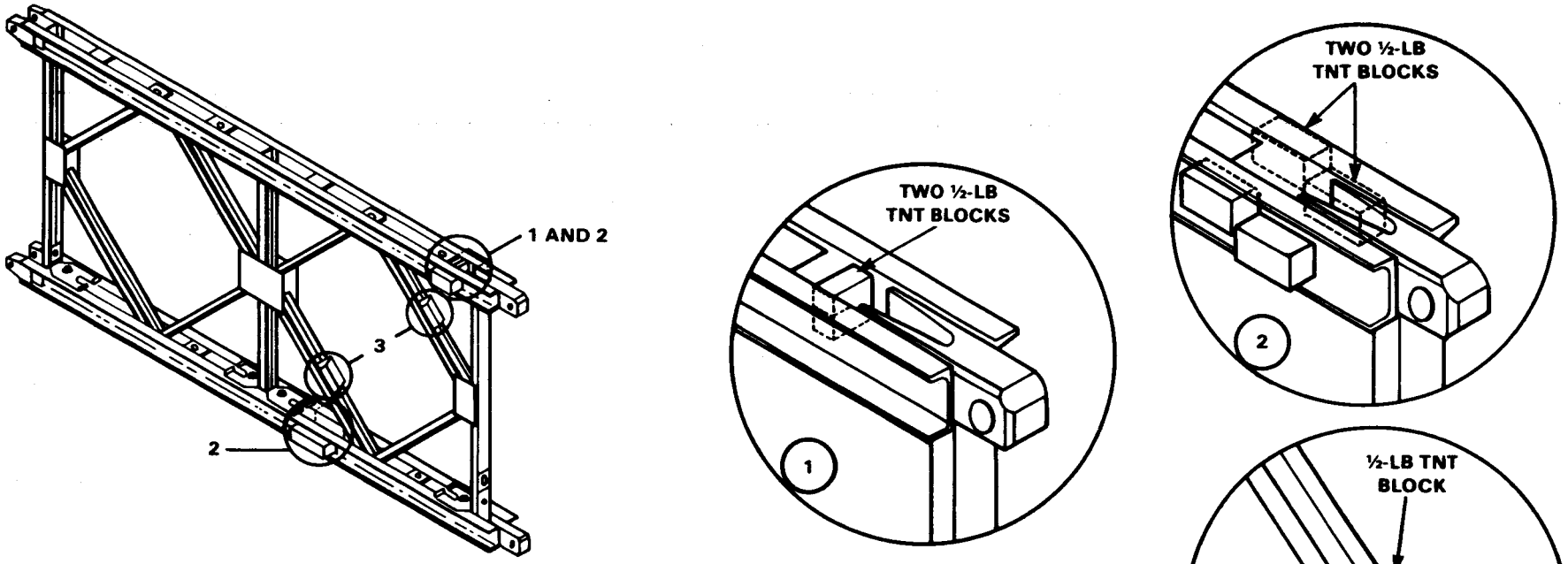


Figure 23-2 ***Destruction of assembled bridge, with placement of charges*** *to cut panel in main girder*

charges on the chords at the junction line of the stories.

For further destruction, place charges on component parts of the bridge, such as panels, transoms, and stringers (Figures 23-2 and 23-3). Stack and bum decking.

Charges and methods of placing various explosives are given in Table 23-1 (page 294). Wedge all charges in place. Use methods and charges described in FM 5-25 for destroying abutments.

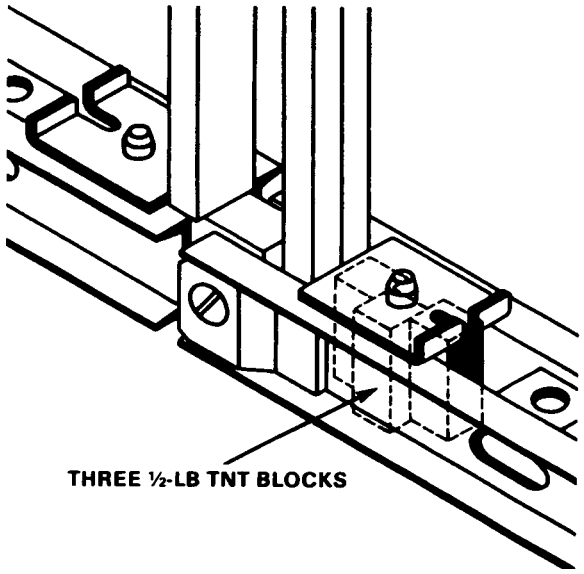


Figure 23-3 ***Destruction of parts of assembled bridge, with placement of charges*** *to destroy lower female lugs pinned to adjoining panels*

Table 23-1 ***Destruction of assembled bridge with its component parts***

PART TO BE CUT OR DESTROYED	PLACEMENT OF CHARGES	FIGURE REF	REMARKS	PREFERRED EXPLOSIVE	CHARGE INDIVIDUAL	CHARGE TOTAL
DESTRUCTION OF ASSEMBLED BRIDGE		25-1				
Panel		25-2				
	CHORDS		PREFERRED METHOD			
	Between channels of chord	25-2	Uses less explosive; wedging necessary; TNT blocks require excessive wedging	Composition C4	1 lb	2 lb per panel
			ALTERNATE METHOD			
	Between flanges of channels on each side of chord	25-2	For TNT blocks, use wedging	TNT	1 lb	4 lb per panel
	DIAGONALS					
	Between flanges of channel	25-2	Use wedging	TNT	½ lb	1 lb per
				Composition C4	½ lb	1 lb panel
Sway braces	A point where two braces cross	25-1	Tie charge to braces	TNT	2 lb	2 lb per
				Composition C4	2 lb	2 lb pair
				Tetrytol	2½ lb	2½ lb braces
DESTRUCTION OF PARTS IN ASSEMBLED BRIDGE		25-3				
Panels (lower-chord female lug pinned to adjoining panel)	Between channels of lower chord behind end vertical		Considerable wedging required with TNT blocks as they can only be inserted staggered	TNT	1½ lb	1½ lb per
				Composition C4	1½ lb	1½ lb lug
Transoms	On web		Use wedging	TNT	1 lb	1 lb per
				Composition C4	1 lb	1 lb transom
Stringers	On web of each I-beam		Put charge on each of the three I-beams in each stringer	TNT	1 lb	3 lb per
			Use wedging	Composition C4	1 lb	3 lb stringer
Chess			Remove from bridge, stack, and burn			

DESTRUCTION OF STACKED EQUIPMENT

Destroy panels and transoms in stacks. To dispose of stringers, ramps, jacks, rollers, small parts, and erection tools, dump them over large areas in places such as the sea, rivers, or woods. Bum decking. Methods of destruction are described in Table 23-2, and shown in Figures 23-4 and 23-5 (page 296). Tamp all charges.

DESTRUCTION OF CABLE REINFORCEMENT SET

When capture or abandonment of the cable reinforcement set is imminent, the responsible unit commander must make the decision either to destroy the equipment or to make it inoperative. Based on this decision, that commander orders how much should be destroyed. Whatever method of demolition used, it is essential to destroy the same vital parts of all cable reinforcement sets and all corresponding repair parts.

For demolition by mechanical means, use sledgehammers, crowbars, picks, axes, or any other heavy tool available to destroy the post assemblies, fixtures, and braces; the cable-connection beams and span junction posts; the cable assemblies; and the cable-tensioning or manual hydraulic-pump assem-

Table 23-2 ***Destruction of stacked equipment***

PART TO BE CUT OR DESTROYED	PLACEMENT OF CHARGES	FIGURE REF	REMARKS	PREFERRED EXPLOSIVE	CHARGE INDIVIDUAL	CHARGE TOTAL
Panels (stacked vertically or horizontally)	Between jaws of lower female lug, in alternate and end panels	25-4	Use wedging TNT blocks cannot be fitted between jaws	Composition C4	1 lb	1 lb per two panels
Panels (stacked horizontally only)	Between channels of lower chord behind end vertical at female lug	25-3	Use wedging Considerable wedging is required with TNT blocks, as they can only be inserted staggered	TNT Composition C4	1½ lb 1½ lb	1½ lb per two 1½ lb panels
Transoms (stacked side by side)	Across top flange on an angle, and between alternate pairs of transoms at varying distances from end	25-5	Use wedging Blow both charges simultaneously to distort transoms and cut large pieces out of webs and top flanges	TNT Composition C4	Enough to be laid end to end across top flange 1 lb between alternate transoms	Approximately 1 lb per transom 1 lb per two transoms
Transoms (not stacked)	On web		Use wedging	TNT Composition C4	1 lb 1 lb	1 lb per 1 lb transom
Chess			Spread out, thoroughly soak with gasoline or diesel oil, and burn; ignite by exploding two or three strands of primacord wrapped around a can of gasoline			
Stringers, ramps, ribbands, jacks, rollers, and erection tools			Scatter in sea, rivers, woods, or over a large area			

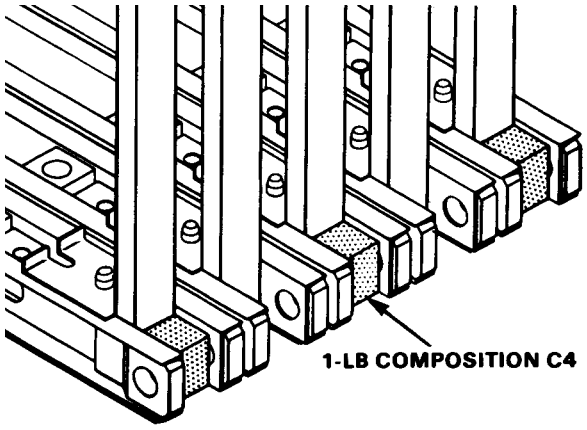


Figure 23-4 ***Destruction of stacked panels, with placement of charges*** *between lower female lugs of alternate and end panels*

blies. For demolition by explosives, place as many charges as the situation permits. Detonate charges simultaneously with detonating cord and suitable detonator. Place at least one ½-pound (.2 kilo) charge on each cable and each cable-connection beam assembly. For demolition by weapons, fire on the cable-connection beams and vertical posts with the heaviest suitable weapons available.

All operators should be thoroughly trained in the destruction of the cable reinforcement set. Simulated destruction, using all methods listed above, should be included in the operator training program. It must be emphasized in training that demolition preparations are usually made in critical situations with little time available for destruction. For this reason, operators must be fully familiar with all methods of destruction of equipment and be able to carry out demolition instructions without reference to this or any other manual.

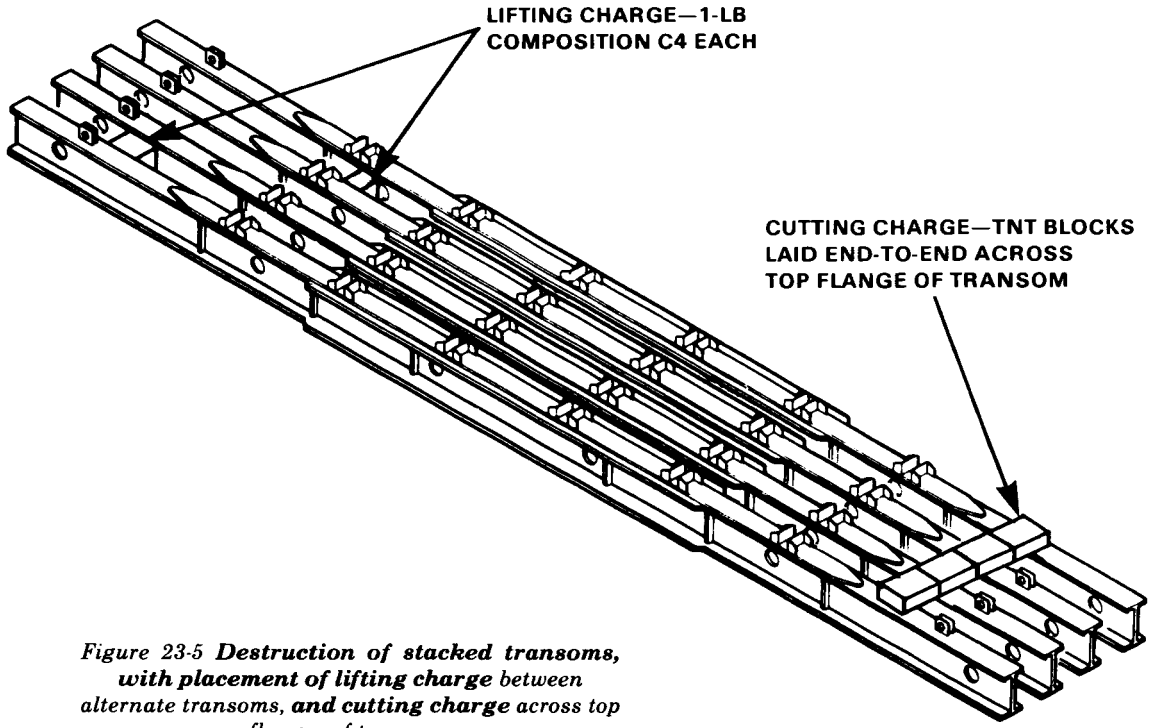


Figure 23-5 ***Destruction of stacked transoms, with placement of lifting charge*** *between alternate transoms,* ***and cutting charge*** *across top flanges of transoms*

APPENDIX A

OVERSIZED TABLES

See pocket envelope inside back cover for uneven-numbered pages 297.1 through 321. Even-numbered pages 298 through 322 are blank.

APPENDIX B

CABLE REINFORCEMENT SET

Tables B-1 and B-2 of this appendix list items which accompany the cable reinforcement set for installation or crew maintenance, as well as supplies needed for initial operation of the set. Figure B-1 (page 324) shows the five basic issue items listed in Table B-1. Figures B-2 through B-5 (pages 325 through 328) and Tables B-3 (page 329) and B-4 (page 330), show maintenance and troubleshooting procedures for the set, as described in Chapter 15. Table B-5 (page 331) lists the repair parts needed to maintain the set, while Figures B-6 through B-12 (pages 332 through 336) show a number of these parts separately.

Table B-1 ***Basic issue items***

ACCESSORIES (DESCRIPTION)	QUANTITY PER UNIT	ILLUSTRATION FIGURE	ILLUSTRATION ITEM
Chair, boatswain with safety belt, 24"x10"	4	B-1	1
Bag, lineman's tool, round	4		
Gage, cable-tension, dial indicating 60-ton cap	3	B-1	2
Hose assy, short	8	B-1	3
Hose assy, long	6	B-1	3
Rope, manila 1200' coil, 2" circ	1	B-1	4
Wrench, box: steel; slugging-type; 12 pt; 2⅝"	4	B-1	5

Table B-2 ***Maintenance and operating supplies***

COMPONENT APPLICATION	DESCRIPTION	QUANTITY REQUIRED FOR INITIAL OPERATION	QUANTITY REQUIRED FOR 8-HR OPERATION	NOTES
Cable assembly	Oil, lubricating, 5-gal can	AR	AR	Fed Spec VV-L-751
Threaded parts and unpainted surfaces	Grease, general purpose	AR	AR	MIL-G-23549
Cable tensioning	Oil, lubricating, 1-gal can	AR	AR	MIL-L-10295

1 CHAIR, BOATSWAIN WITH SAFETY BELT*
2 GAGE, CABLE-TENSION*
3 HOSE ASSEMBLY*
4 ROPE, MANILA*
5 WRENCH, BOX: STEEL; SLUGGING-TYPE*

* FOR SPECIFIC DETAILS SEE TABLE B-1

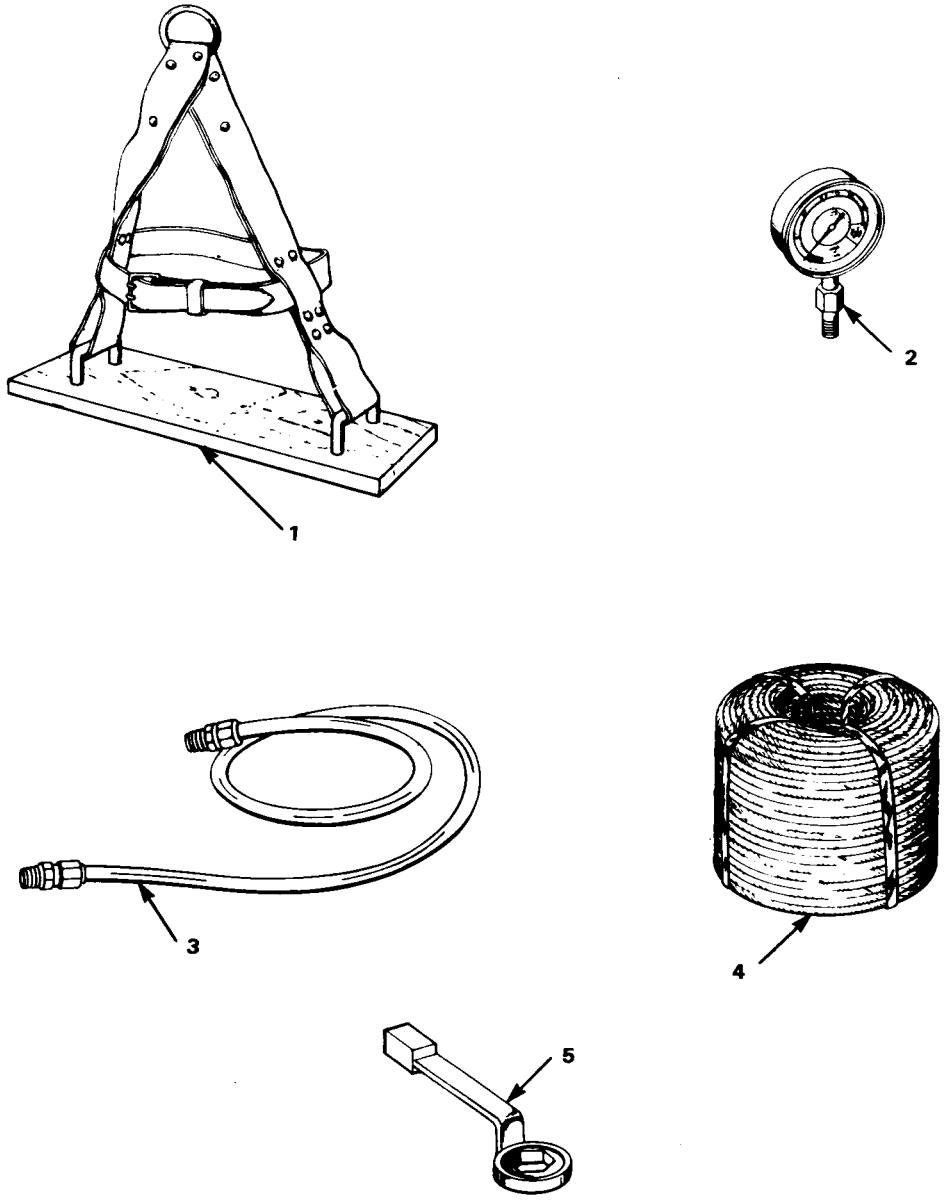
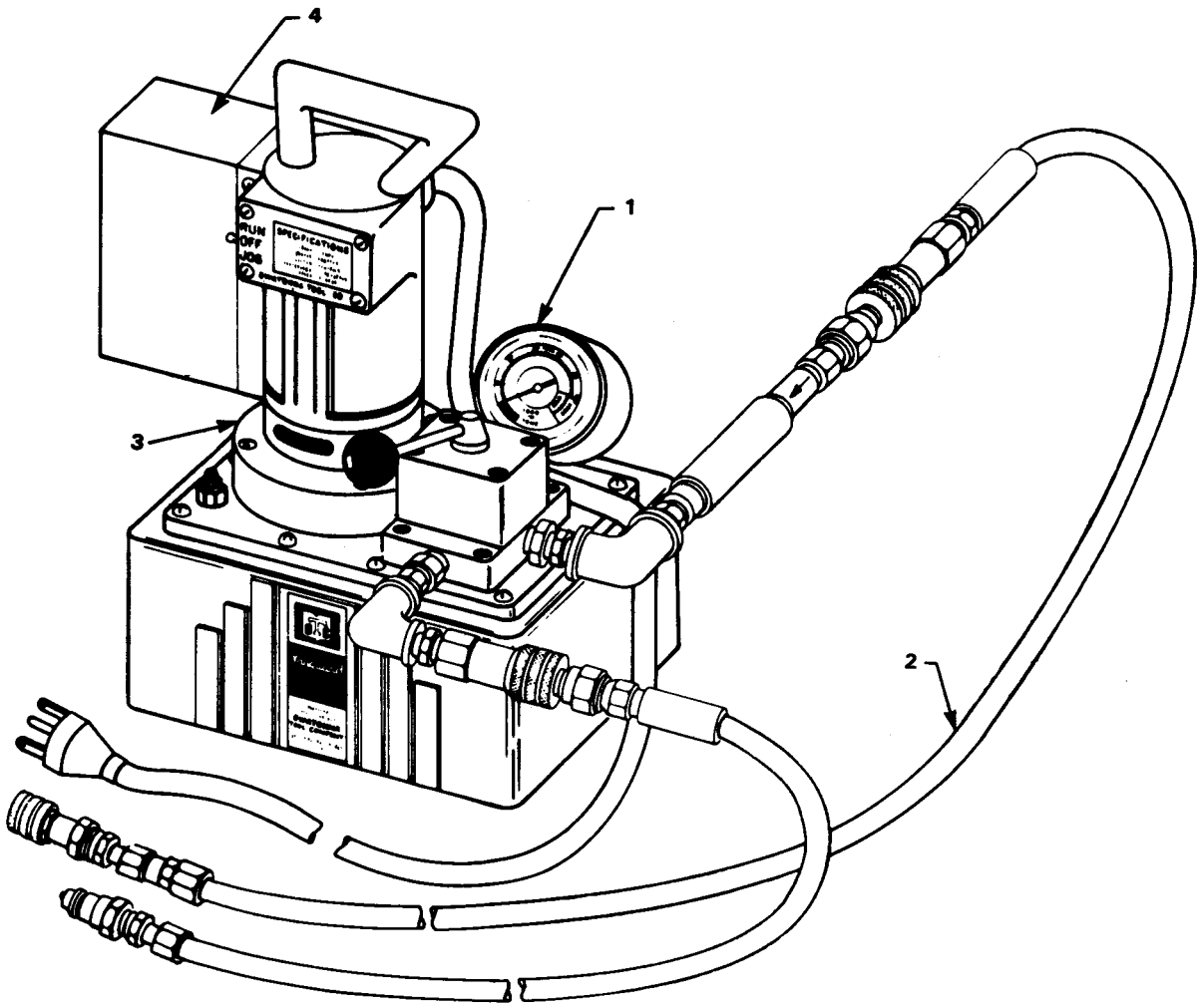


Figure B-1 ***Basic issue items***



1 DIAL-INDICATING CABLE-TENSION GAGE
2 HOSE ASSEMBLY
3 FILL PLUG
4 HYDRAULIC POWER UNIT

STEP 1
REMOVE FILLER PLUG FROM TOP OF PUMPING UNIT RESERVOIR; OIL SHOULD BE 3" BELOW TOP SURFACE OF RESERVOIR

STEP 2
ADD OR DRAIN HYDRAULIC OIL CONFORMING TO SPECIFICATION MIL-L-10295, LUBRICATION OIL, OES 10. DO NOT OVERFILL

STEP 3
REINSTALL FILLER PLUG IN TOP OF PUMPING UNIT RESERVOIR

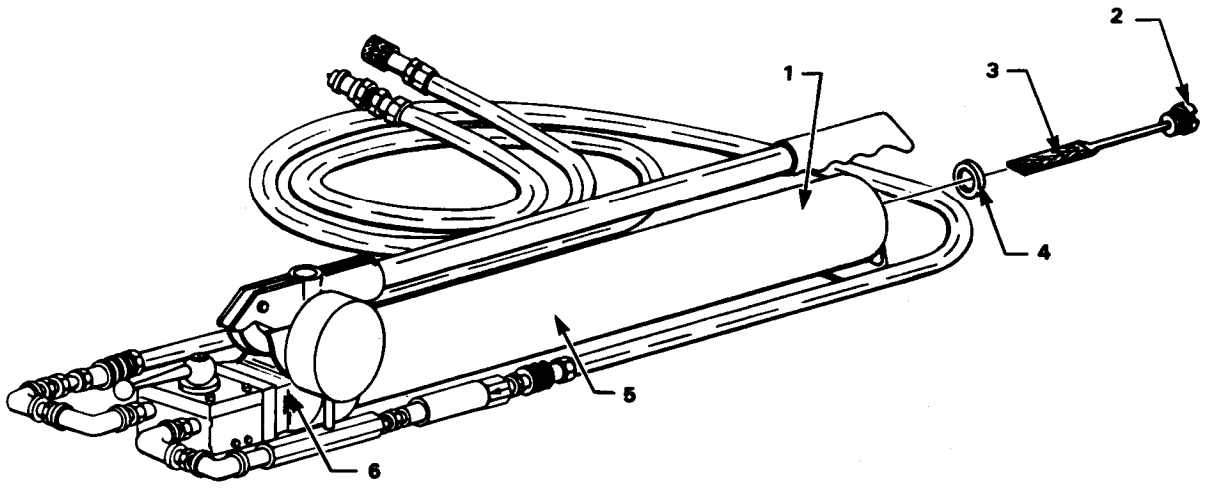
Figure B-2 ***Servicing hydraulic power unit reservoir***

STEP 1
PLACE PUMPING UNIT IN VERTICAL POSITION WITH HOSE END DOWN

STEP 2
REMOVE FILLER PLUG AND GASKET FROM UPPER END OF PUMPING UNIT RESERVOIR; OIL SHOULD BE VISIBLE ON FLAT PART OF DIPSTICK

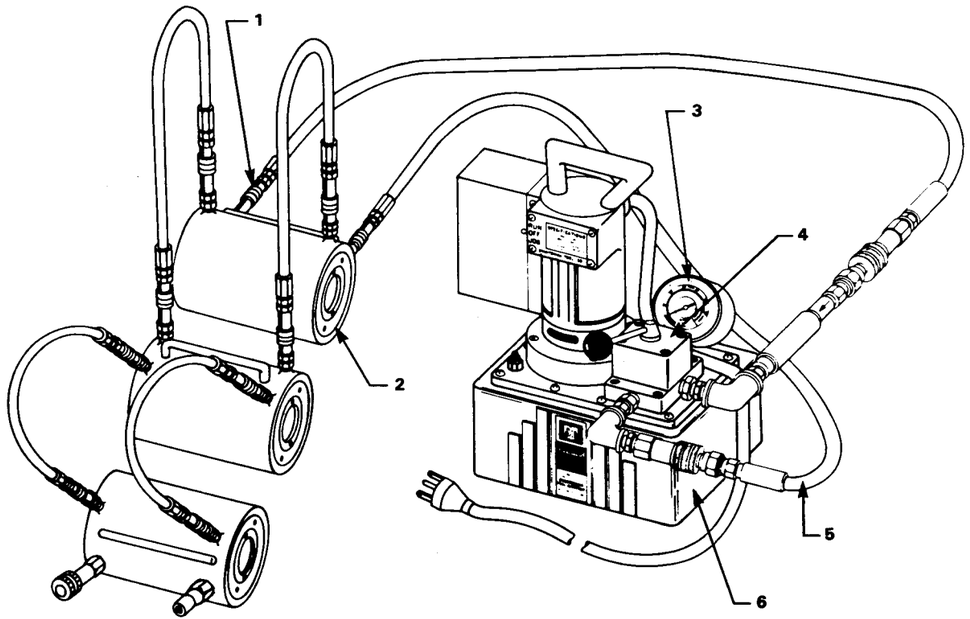
STEP 3
ADD OR DRAIN HYDRAULIC OIL CONFORMING TO SPECIFICATION MIL-H-10295, LUBRICATION OIL, OES 10; DO NOT OVERFILL

STEP 4
REINSTALL GASKET AND FILLER-PLUG ASSEMBLY IN END OF PUMPING UNIT RESERVOIR; THEN RETURN PUMPING UNIT TO HORIZONTAL POSITION



1 UPPER END OF RESERVOIR	4 GASKET
2 FILLER-PLUG ASSEMBLY	5 RESERVOIR
3 DIPSTICK	6 HAND-DRIVEN HYDRAULIC RAM PUMP

Figure B-3 ***Servicing hand-driven hydraulic ram pump reservoir***



1 QUICK-DISCONNECT COUPLING	4 CONTROL VALVE
2 DOUBLE-ACTING HYDRAULIC CYLINDER	5 HOSE ASSEMBLY
3 DIAL-INDICATING CABLE-TENSION GAGE	6 HYDRAULIC RESERVOIR

Figure B-4 ***Replacement of gage, hose assembly, and/or quick-disconnect coupling of cable-tensioning assembly***

STEP A
1 UNSCREW GAGE FROM PORT
2 INSTALL TEMPORARY PLUG TO PREVENT ENTRY OF FOREIGN MATTER IN HYDRAULIC FLUID
3 REMOVE PLUG AND INSTALL NEW GAGE IN PORT

STEP B
1 DISCONNECT QUICK-DISCONNECT COUPLINGS FROM CYLINDER
2 THE FOLLOWING PROCEDURE IS USED TO REPLACE HOSES AND FITTINGS:
(a) PUMP HOSES
(1) UNSCREW MALE QUICK-DISCONNECT COUPLING HALF OR FLOW REGULATOR AND UNSCREW HOSE FROM VALVE FITTING
(2) UNSCREW PIPE FITTINGS FROM VALVE
(3) UNSCREW FLOW REGULATOR FROM PIPE NIPPLE
(4) UNSCREW PIPE NIPPLE FROM FEMALE QUICK-DISCONNECT COUPLING
(5) INSTALL TEMPORARY PLUGS IN ALL PARTS
(6) DISCARD DEFECTIVE PART AND ASSEMBLE IN REVERSE ORDER, ENSURING THAT FLOW REGULATOR IS INSTALLED PROPERLY
(b) CYLINDER HOSE
(1) UNSCREW QUICK-DISCONNECT COUPLING HALF FROM END OF HOSE AND UNSCREW HOSE FROM CYLINDER
(2) INSTALL TEMPORARY PLUGS
(3) INSTALL NEW PARTS IN REVERSE ORDER
3 RECONNECT QUICK-DISCONNECT COUPLINGS TO CYLINDER

STEP C
1 UNSCREW QUICK-DISCONNECT COUPLING HALF FROM PIPE NIPPLE
2 UNSCREW PIPE NIPPLE FROM CYLINDER
3 INSTALL TEMPORARY PLUG IN CYLINDER
4 INSTALL NEW PARTS IN REVERSE ORDER

NOTE: FOLLOWING ANY REPLACEMENT PROCEDURES, REFER TO FIGURE 15-57 FOR CHECKING FLUID LEVEL OF HYDRAULIC SYSTEM; ADD OR REMOVE HYDRAULIC FLUID TO MAINTAIN PROPER FLUID LEVEL FOR EFFICIENT OPERATION OF CABLE-TENSIONING ASSEMBLY

1 FEMALE QUICK-DISCONNECT COUPLING END
2 RESERVOIR
3 HOSE ASSEMBLY
4 FLOW REGULATOR
5 GAGE ADAPTER
6 DIAL-INDICATING CABLE-TENSION GAGE
7 CONTROL VALVE
8 MALE QUICK-DISCONNECT COUPLING END

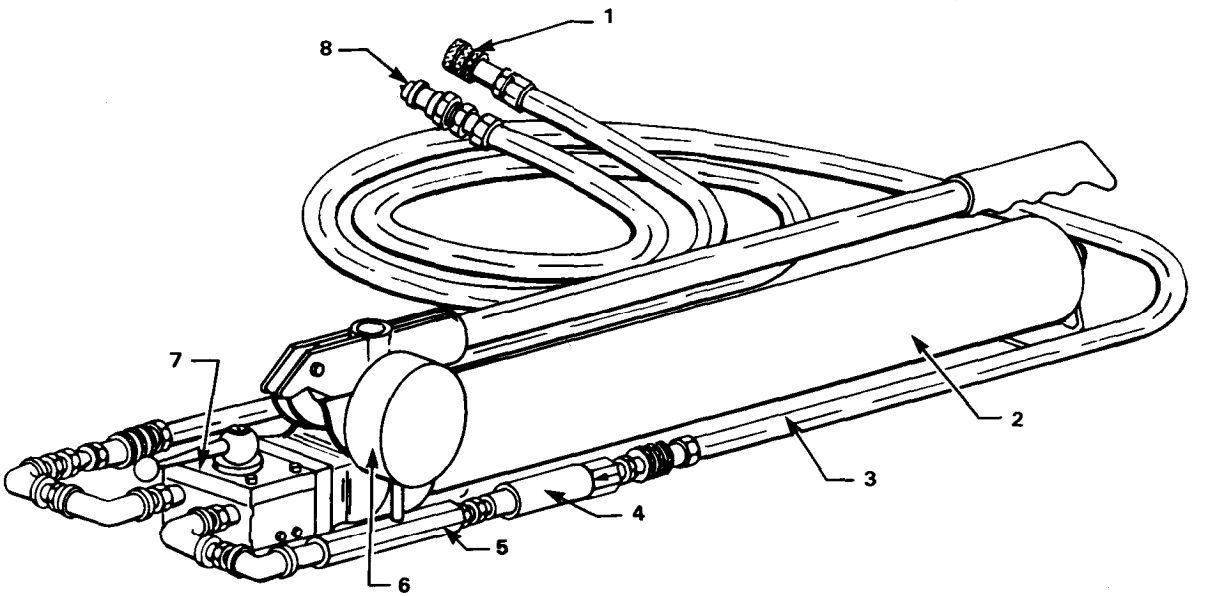


Figure B-5 ***Replacement of gage, hose assembly, quick-disconnect coupling, and/or gage adapter of manual hydraulic-pump assembly***

STEP A
1 UNSCREW GAGE FROM PORT OF GAGE ADAPTER
2 INSTALL TEMPORARY PLUG TO PREVENT ENTRY OF FOREIGN MATTER IN HYDRAULIC FLUID
3 REMOVE PLUG AND INSTALL NEW GAGE IN PORT OF GAGE ADAPTER

STEP B
1 UNSCREW MALE QUICK-DISCONNECT COUPLING FROM ONE HOSE AND UNSCREW HOSE FROM BUSHING AT VALVE; DISCONNECT FLOW REGULATOR FROM OTHER HOSE AND UNSCREW HOSE FROM BUSHING AT GAGE ADAPTER
2 UNSCREW BUSHING FROM VALVE AND GAGE ADAPTER
3 UNSCREW GAGE ADAPTER FROM VALVE
4 UNSCREW FLOW REGULATOR FROM PIPE NIPPLE
5 UNSCREW PIPE NIPPLE FROM FEMALE QUICK-DISCONNECT COUPLING
6 INSTALL TEMPORARY PLUGS IN ALL PARTS
7 DISCARD DEFECTIVE PARTS AND REASSEMBLE NEW PARTS IN REVERSE ORDER OF DISASSEMBLY; MAKE CERTAIN THAT FLOW REGULATOR IS INSTALLED PROPERLY

NOTE: FOLLOWING ANY REPLACEMENT PROCEDURES, REFER TO FIGURE 15-58 FOR CHECKING FLUID LEVEL OF HYDRAULIC SYSTEM; ADD OR REMOVE HYDRAULIC FLUID TO MAINTAIN PROPER FLUID LEVEL FOR EFFICIENT OPERATION OF HAND-DRIVEN HYDRAULIC RAM PUMP

Table B-3 ***Cable reinforcement set—preventive maintenance checks and services***

ITEM TO BE INSPECTED	INTERVAL OPERATOR—CREW DAILY B	D	A	W	ORGANIZATIONAL M	B—BEFORE OPERATION D—OPERATION A—AFTER OPERATION W—WEEKLY M—MONTHLY PROCEDURE
Cable	X			X	X	Inspect for kinks, broken wires, and fraying around cable buttons; check cable at vertical-post saddle for excessive wear
Rod-to-cable coupling	X			X		Check for security to cable stud; retighten set screw
Pull rods	X			X	X	Inspect threads for cleanliness, burrs, and binding of cable and cylinder nuts, which may indicate stripped threads
Half-cable retainer				X		Check for security between bearing surface of cable-connection beam and cable button
Saddle on vertical-post base	X					Inspect for sharp edges which could cause excessive wear of cable; dress burred surfaces
Hydraulic cylinder assemblies	X			X		Inspect fittings, reservoir, hose assemblies, and cylinders for leakage of oil
Bolts and nuts				X	X	Check security of all parts; bolts should be turned one quarter beyond handtightness
Cable tension	X			X		Pressurize cylinder until cable nuts are free from connection-beam bearing surface; with no vehicles on bridge, gage should read correct value from Table 15-1, allowing for temperature variation; either hand pump or hydraulic power unit can be used
Bridge-seat rockers	X	X	X	X	X	Visually inspect for proper emplacement, breakage, and wear

Table B-4 Troubleshooting

MALFUNCTION	PROBABLE CAUSE	CORRECTIVE ACTION
1. Failure to attain deflection within limits specified (Table 15-1)	a. Leak in cable-tensioning assembly causing low or no pressure in hydraulic-cylinders	a. Inspect for leakage in hydraulic power unit, hose assembly, or fittings; service hydraulic-cylinder assembly or replace components or assembly with new parts
	b. Defective cable-tension gage	b. If inspection indicates defective gage, replace with new part
	c. Collapse of vertical post	c. Inspect for broken welds, loose bracing, or connection fixtures; repair welds and retighten all loose parts
	d. Stripped threads on pull rod	d. Replace pull-rod assembly
	e. Collapse of cable	e. Inspect for proper position of half-cable retainers or broken wires; reposition and secure half cable retainers; replace cable assembly if broken wires are found; retension cable in accordance with Table 15-1
2. Failure to maintain deflection within limits specified (Table 15-1)	a. Yielding of buttons or stud or cable assembly	a. Replace cable assembly
	b. Inelastic deformation of cable	b. Retension cable in accordance with Table 15-1
	c. Stripping of threads on pull rod	c. Replace pull rod

FIELD EXPEDIENT REPAIRS

MALFUNCTION	EXPEDIENT REMEDY
1. Failure of one cable-tensioning assembly	One cable-tensioning assembly may be used to tension the cables as follows: Tension cables on one side to 5 tons, then tension the other side to 5 tons; Continue alternating at 5-ton increments to the tension indicated in Table 15-1, following steps in this chapter, "Cable Tensioning" section.
2. Defective dial-indicating cable-tension gage	Tension cable and measure upward deflection of the truss continuously; the vertical deflections to produce required cable tension are shown in Table 15-1.

Table B-5 ***Repair parts list***

ACCESSORIES (DESCRIPTION)	QUANTITY PER UNIT	ILLUSTRATION FIGURE	ITEM
Adapter, hydraulic cylinder	6	B-9	8
Beam, cable-connection, LH	2	B-8	1
Beam, cable-connection, RH	2	B-8	1
Rocker, bridge-seat: steel	6	B-8	4
Screw, cap: hex hd, steel, cad pltd, ¾" diam, 1½" lg, 10UNC-2A	66	B-6 B-7	10 3
Screw, cap: hex hd, steel, cad pltd, ¾" diam, 2¾" lg, 10UNC-2A	16	B-6	7
Screw, cap: hex hd, steel, cad pltd, ½" diam, 4½" lg, 13UNC-2A	10	B-11 B-9	2 18
Bolt: hex hd, steel, 1¾" diam, 7" lg, 5UNC-2A	40	B-6	4
Brace, longitudinal: 8'¼" lg	8	B-6	6
Brace, transverse: 7'4½" lg	4	B-7	1
Brace, transverse: 10' lg	4	B-7	2
Cable and reel assy	6	B-11	1
Screw, cap: hex hd, steel, cad pltd, ½" diam, 1' lg, 13UNC-2A	6	B-9	20
Cable: 179'6" lg	6	B-9	21
Coupling, rod-to-cable	6	B-9	19
Fixture, brace-connection, RH: 34" lg	4	B-6	5
Fixture, brace-connection, LH: 34" lg	4	B-6	13
Fixture, post-connection: 34¼" x 40" x 12⅝"	4	B-6	1
Nut, plain: hex, ½" diam, 13UNC-2B thd	10	B-9 B-11	17 3
Nut, heavy: hex, ¾" diam, 10UNC-2B thd	82	B-6 B-7	8 4
Nut, plain: hex, steel, 1¾" diam, cad pltd, 5 UNC-2B thd	40	B-6	3
Plate, chord: steel, 7" x 7" x ⅜"		B-6	2
Retainer, cable, half: steel	6	B-8	3
Post, vertical: steel, 7' 1½" lg	4	B-6	9
Retainer, cable	4	B-6	12
Screw, cap: hex hd, steel, cad pltd, ½" diam, 1½" lg, 13UNC-2A thd	16	B-6	11
Nut, plain: hex, steel, cad pltd, ½" diam, 13UNC-2B thd	16	B-9	17
Reel, cable: 50" diam x 24 ¾" wide, 5½" center hole	6	B-11	4
Rod, pull: steel, 70" lg	6	B-9	16
Nut, serrated, cables & cylinder: 2" diam, 4½" UN-2B	12	B-9	1
Chain, pull-rod: steel	2	B-9	6
Rope, manila: 2" circ x 1200' lg	1		
Shaft, cable-reel: 3½" diam, 10' lg pipe	2	B-11	1
Hose and coupling assy, female: ¼" diam x 2' lg, with ¼" NPTF female quick-disconnect couplings each end	4	B-9	2
Hose and coupling assy, male: ¼" diam x 2' lg, with ¼" NPTF male quick-disconnect couplings each end	4	B-9	4
Hose and coupling assy, female: ¼" diam x 10' lg with ¼" NPTF female quick-disconnect couplings each end	2	B-9	9
Hose and coupling assy, male: ¼" diam x 10' lg, with ¼" NPTF male quick-disconnect couplings each end	2	B-9	10
Hose and coupling assy, female: ¼" diam x 10' lg, with ¼" NPTF female quick-disconnect couplings each end	1	B-10	3
Hose and coupling assy, male: ¼" diam x 10' lg, with ¼" NPTF male quick-disconnect couplings each end	1	B-10	4
Support, cable-reel: steel, 48" x 42" x 36"	4	B-11	5
Adapter, gage HP 2344: ⅜" x ⅜" x ¼" NPTF	2	B-10	6
Coupling, male half (quick-disconnect), ¼" NPT	12	B-9	5
Coupling, female half (quick-disconnect), ¼" NPT	12	B-9	3
Elbow, 90°: ¼" NPT	2	B-9	11
Valve, hydraulic, flow-control: ¼" NPTF	2	B-9	12
Bushing: ⅜" NPTF x ¼" NPTF	4	B-9	14
Lug, jacking: steel	4		
Coupling, male half (quick-disconnect), ¼" NPT	1	B-10	2
Coupling, female half (quick-disconnect), ¼" NPT	1	B-10	1
Valve, hydraulic, flow-control: ¼" NPT, 1908-2-2.0	1	B-10	8
Nipple: hex, ¼" NPTF	1	B-10	5
Bushing, pipe hexagon: ⅜" NPTF x ¼" NPTF	2	B-10	
Power unit, hydraulic	2	B-9	15
Gage, cable-tension, dial-indicating	2	B-9	13
Cylinder, hydraulic, double-acting	6	B-9	7
Pump, hydraulic ram, hand-driven	1	B-10	9
Gage, cable-tension, dial-indicating	1	B-10	7
Post, span junction, female	6	B-12	
Post, span junction, male	6	B-12	

1 POST-CONNECTION FIXTURE
2 CHORD PLATE
3 HEX NUT, 1¾"-DIAM
4 CHORD BOLT, 7"-LG
5 BRACE-CONNECTION FIXTURE, RH
6 LONGITUDINAL BRACE
7 HIGH-STRENGTH BOLT, 2¾"-LG
8 HEX NUT, ¾"-DIAM
9 VERTICAL POST
10 HIGH-STRENGTH BOLT, 1½"-LG
11 MACHINE BOLT, 1½"-LG
12 CABLE RETAINER
13 BRACE-CONNECTION FIXTURE, LH

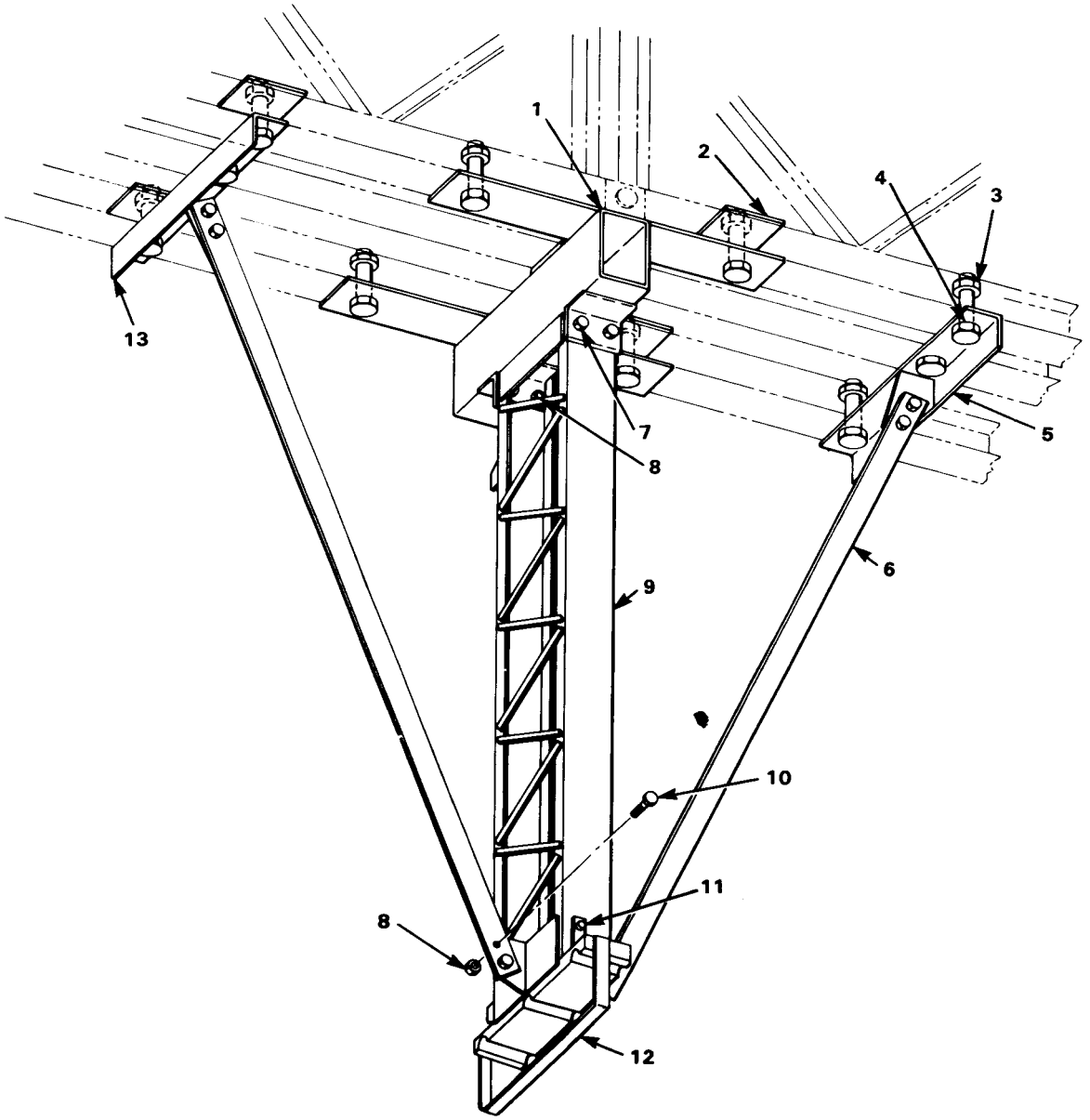
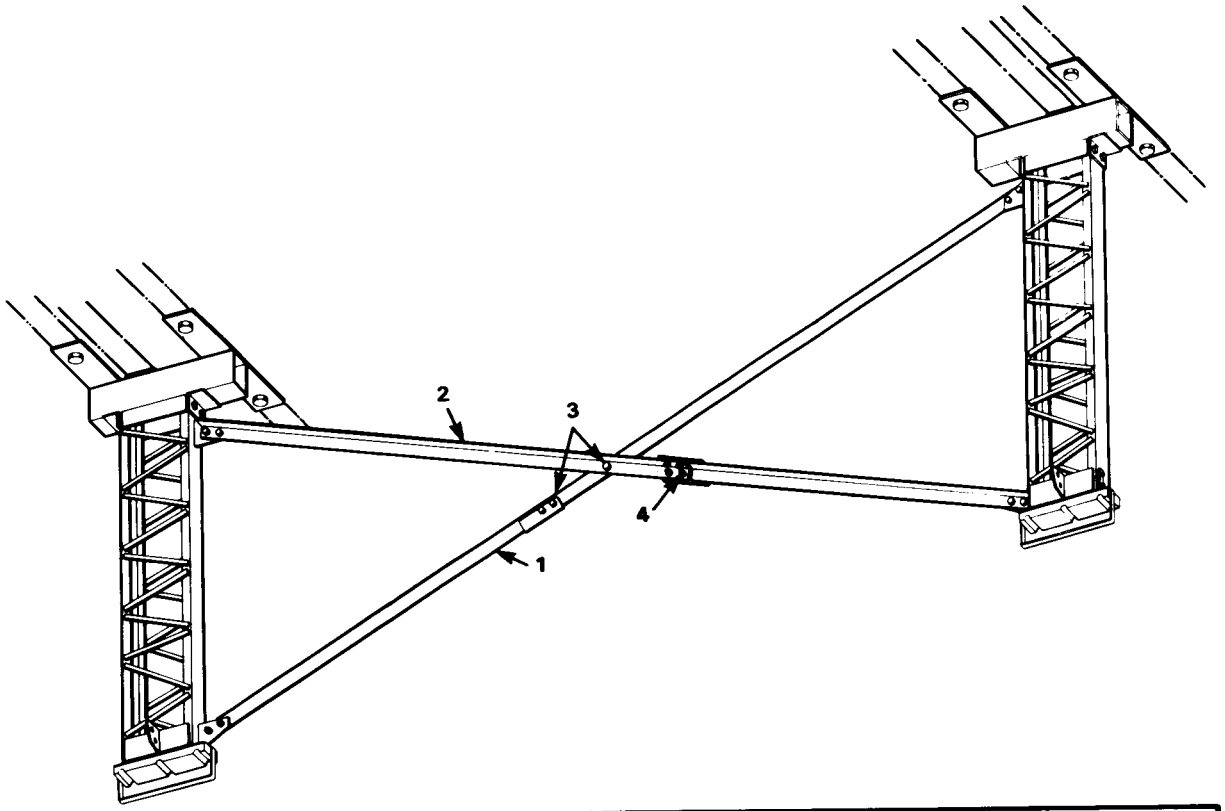
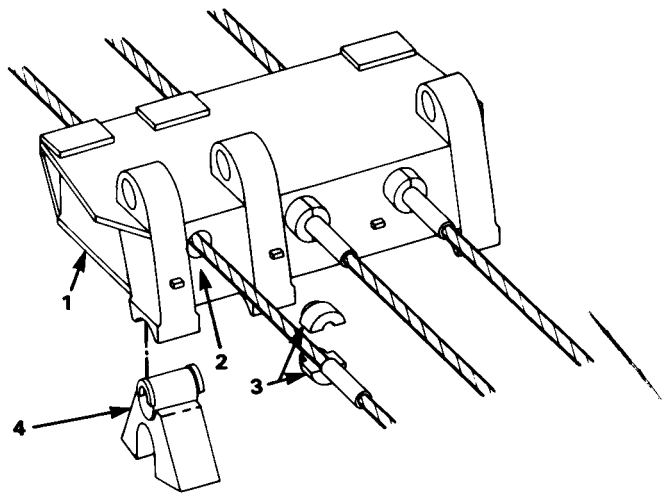


Figure B-6 ***Post-assembly connection fixtures, braces, and related parts***



1 SHORT TRANSVERSE BRACE
2 LONG TRANSVERSE BRACE
3 BOLT, 1½"-LG
4 HEX NUT, ¾"-DIAM

Figure B-7 ***Transverse braces***



1 CABLE CONNECTION BEAM
2 BEARING SURFACE
3 HALF CABLE RETAINER
4 BRIDGE SEAT ROCKER (TENSIONING-END ONLY)

Figure B-8 ***Cable-connection beam and related parts***

1 CABLE AND CYLINDER NUTS
2 HOSE ASSEMBLY (SHORT) FEMALE
3 FEMALE QUICK-DISCONNECT COUPLING
4 HOSE ASSEMBLY (SHORT) MALE
5 MALE QUICK-DISCONNECT COUPLING
6 PULL-ROD CHAIN
7 DOUBLE-ACTING HYDRAULIC CYLINDER
8 ADAPTER
9 HOSE ASSEMBLY (LONG) FEMALE
10 HOSE ASSEMBLY (LONG) MALE
11 90° ELBOW
12 FLOW REGULATOR
13 GAGE, DIAL-INDICATING CABLE-TENSION
14 BUSHING
15 POWER UNIT, HYDRAULIC
16 PULL ROD
17 HEX NUT, ½"-DIAM
18 BOLT, 4½"-LG
19 ROD-TO-CABLE COUPLING
20 BOLT-TYPE SET SCREW
21 CABLE

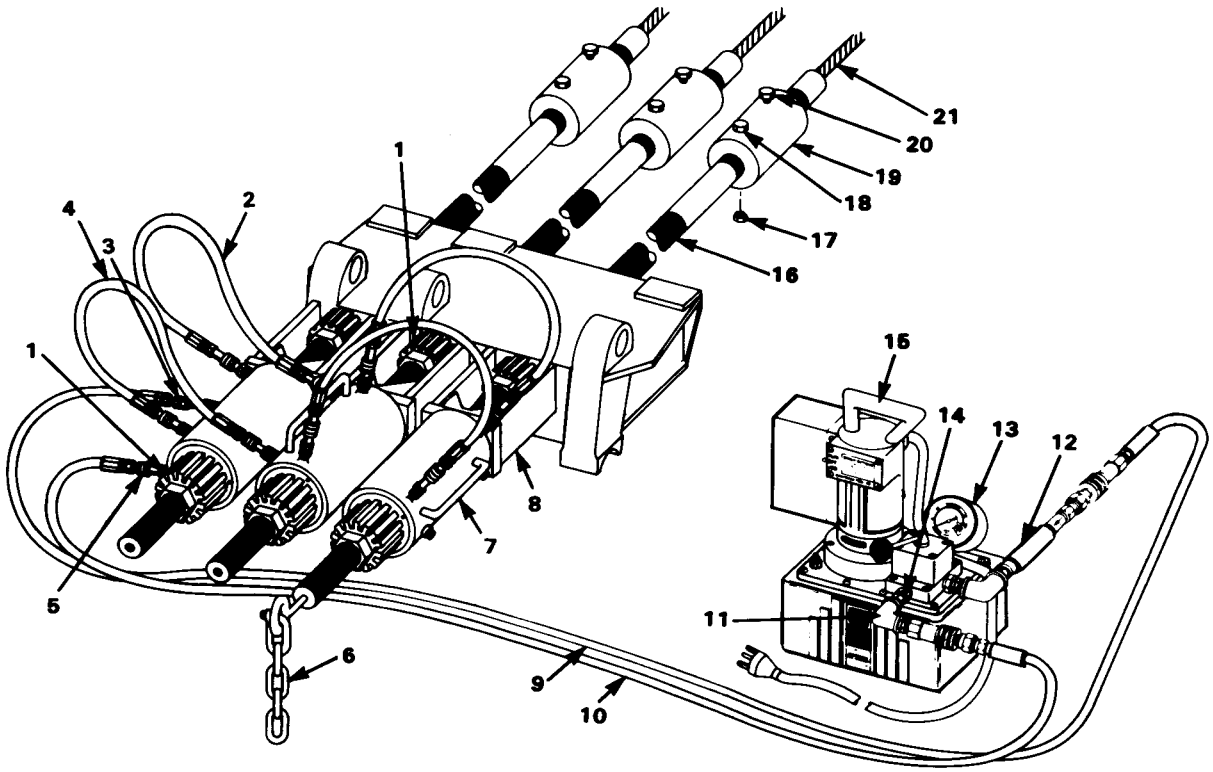
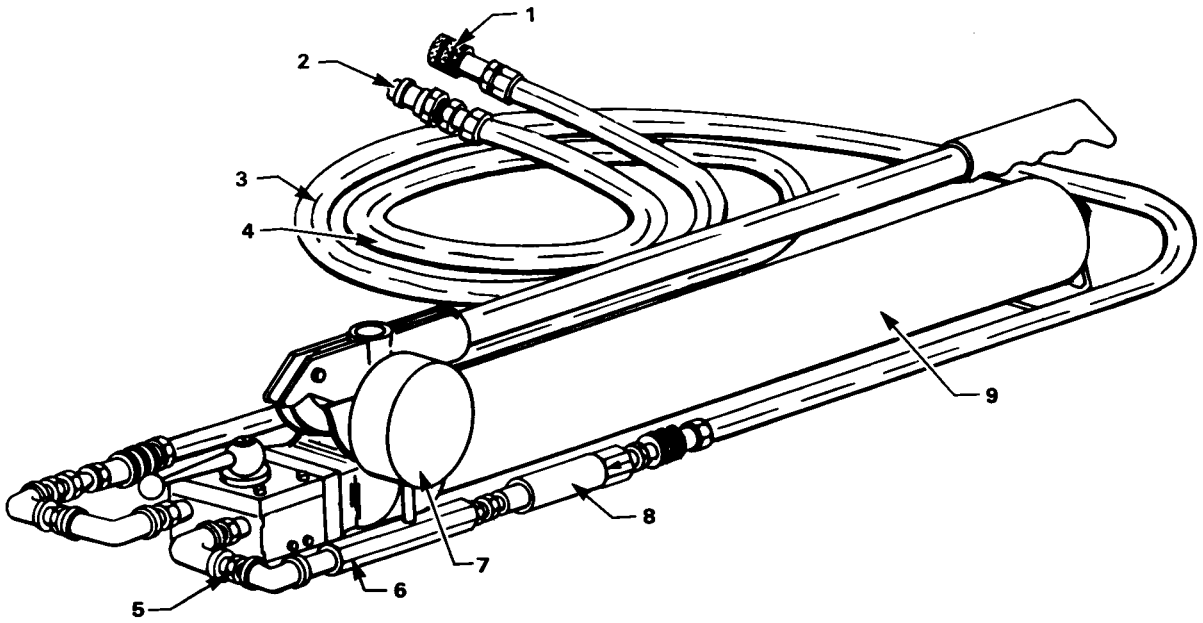
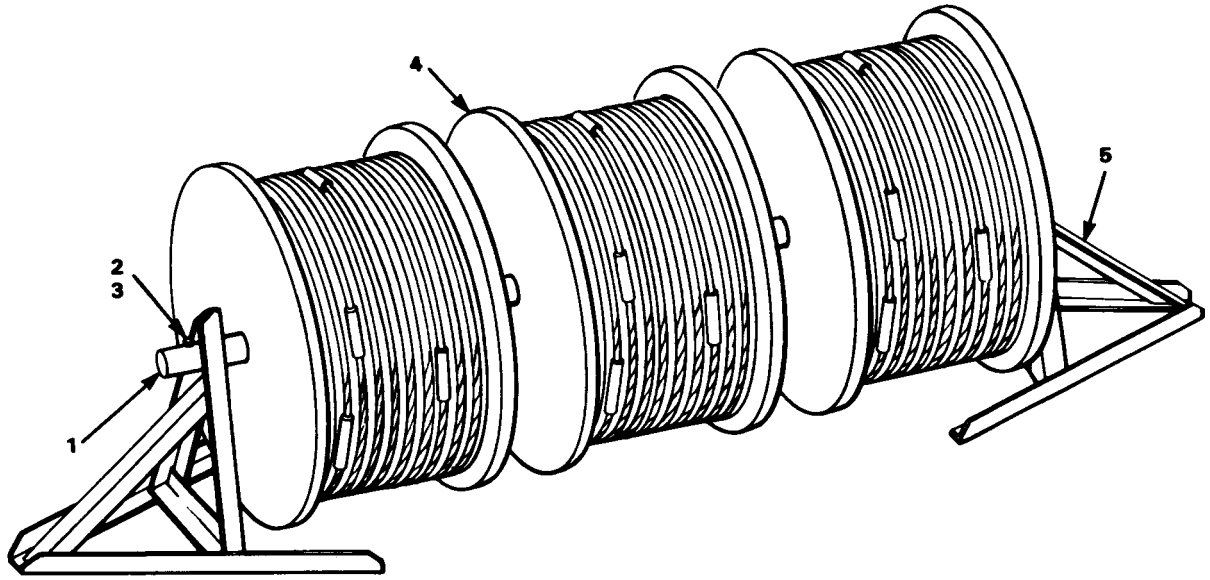


Figure B-9 ***Cable, pull rod, and hydraulic-cylinder assemblies and related parts***



1 FEMALE QUICK-DISCONNECT COUPLING
2 MALE QUICK-DISCONNECT COUPLING
3 HOSE ASSEMBLY, FEMALE
4 HOSE ASSEMBLY, MALE
5 NIPPLE, PIPE, HEXAGON
6 GAGE ADAPTER
7 DIAL-INDICATING CABLE-TENSION GAGE
8 FLOW REGULATOR
9 HAND-DRIVEN HYDRAULIC RAM PUMP

Figure B-10 ***Manual hydraulic-pump assembly***



1 CABLE-REEL SHAFT
2 BOLT, 4½"-LG
3 HEX NUT, ½"-DIAM
4 CABLE REEL
5 CABLE REEL SUPPORT

Figure B-11 ***Cable reel and related parts***

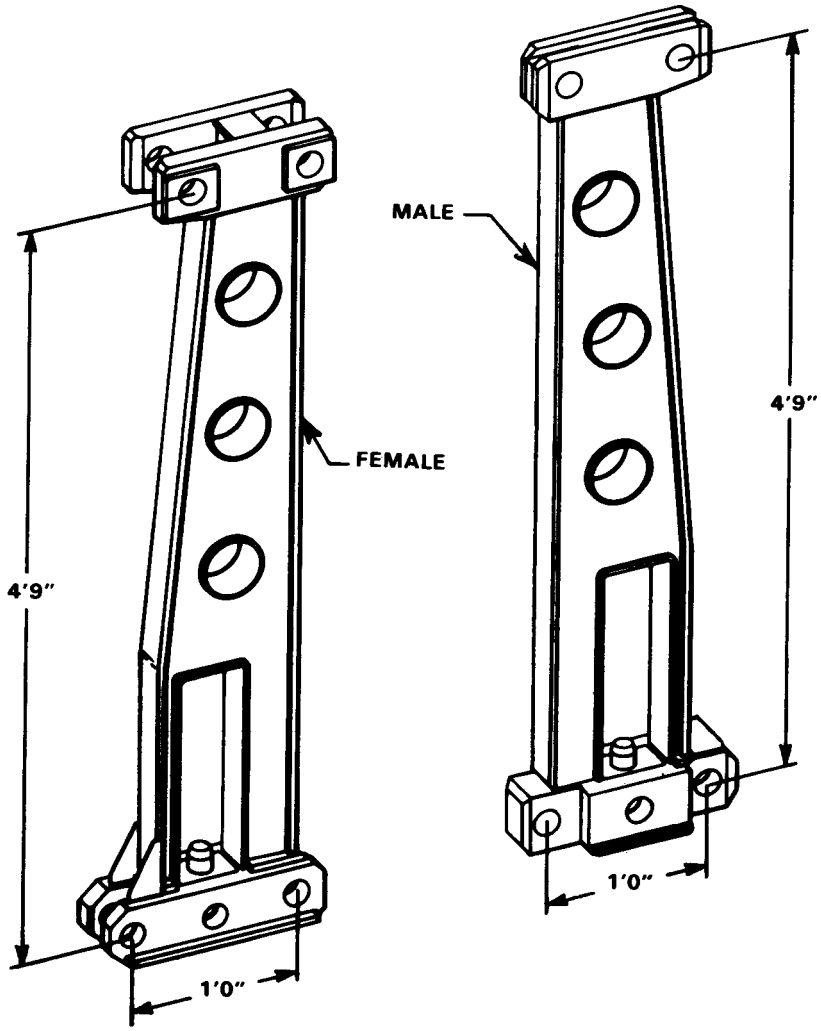


Figure B-12 ***Span junction posts***

APPENDIX C

USE OF SALE CHARTS IN DETERMINING MOMENT AND SHEAR

When a simple horizontal beam is loaded, it deflects, or bends downward, and the horizontal fibers in the lower part of the beam are lengthened (tension) and those in the upper part are shortened (compression). The external forces act to produce a bending moment. The moment of the internal forces (stresses) resisting this bending is called the resisting moment. In Figure C-1, in that part of the beam to the right of section C, the counterclockwise bending moment produced by the external force P and Rr is resisted by the clockwise resisting moment produced by the tensile and compressive stresses in the beam at section C. Within the strength of the material, the resisting moment at any section is equal to the betiding moment at that section. When abeam is designed, the dimensions must be such that the maximum resisting moment that the beam can develop is at least equal to the greatest bending moment that may be imposed on it by the external loads.

BENDING MOMENT

The following procedures, formulas, and other data are relevant to the determination of maximum allowable bending moment:

- The bending moment at any section (point) of a beam for an external load in a specific position is found as follows:

  1 Determine reactions caused by load in this position.

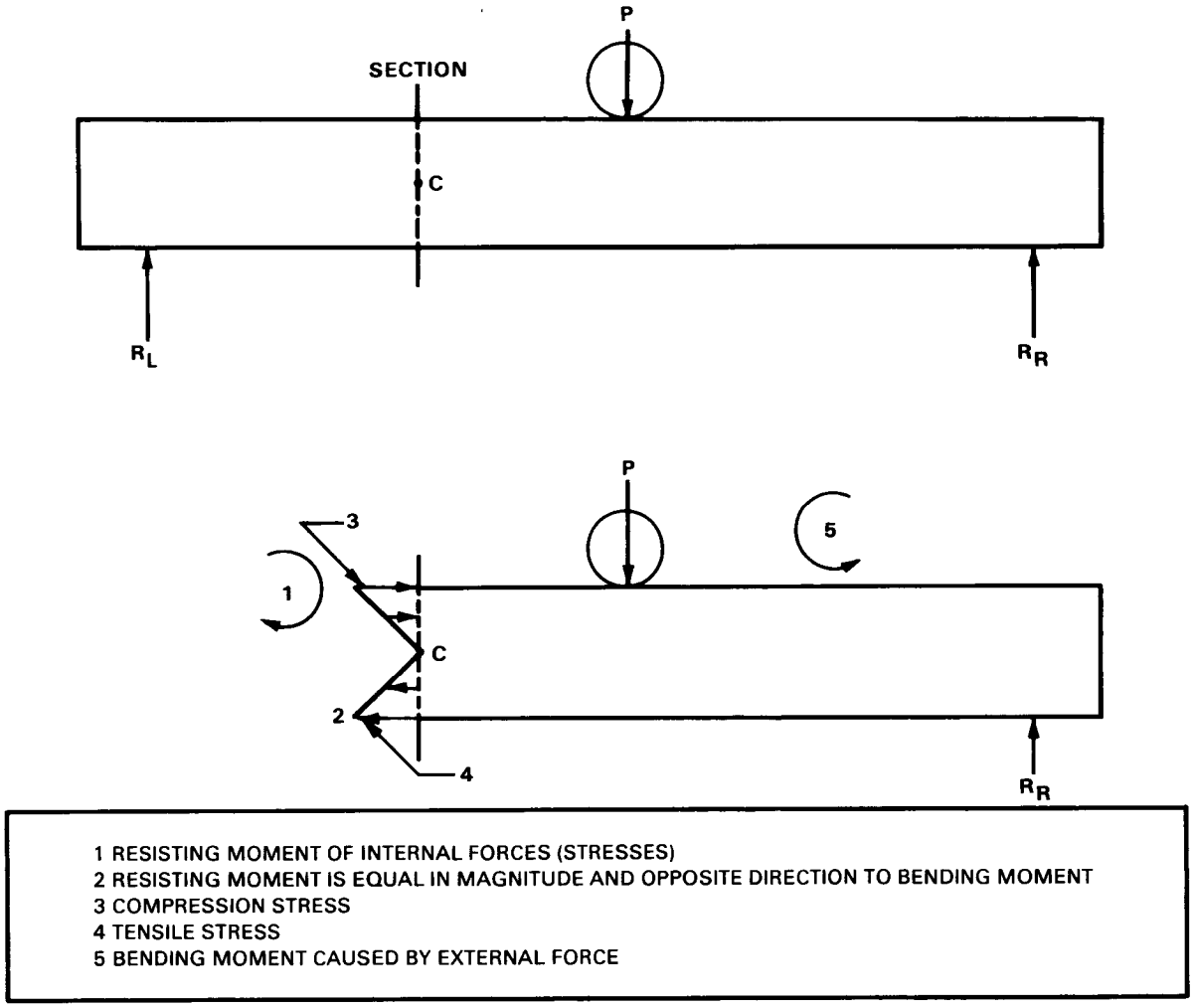


Figure C-1 ***Bending***

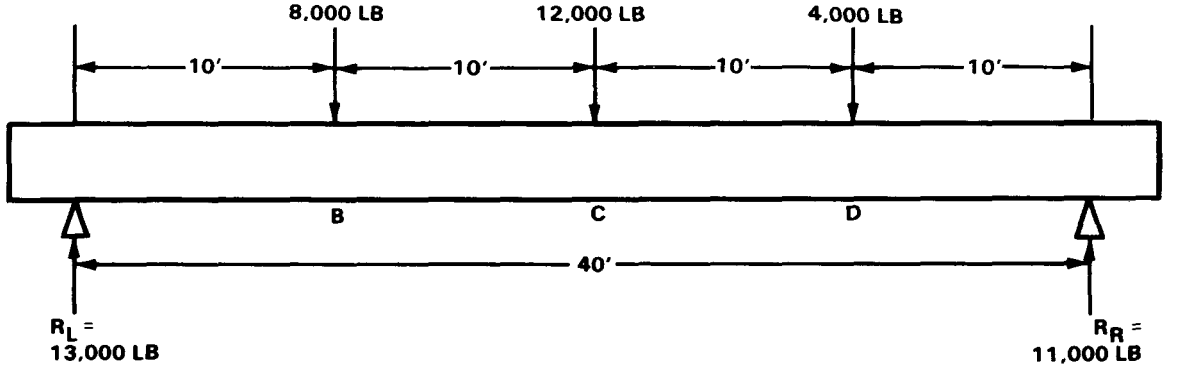


Figure C-2 Problem in bending

2 Take either reaction and multiply it by distance of that reaction from section under consideration.

3 From this product, subtract product of each load applied to beam between reaction and section times the distance from that load to section.

- In Figure C-2, external bending moment at C equals $M_c = (R_L \times 20) - (8{,}000 \times 10) = 260{,}000 - 80{,}000 = 180{,}000$ foot-pounds, or $M_c = 18{,}000 \times 12 = 2{,}160{,}000$ inch-pounds. This may also be found by taking forces from the right end.

- The bending moment at any point in a beam due to a moving load varies with the position of the load. For design, it is necessary to know the maximum moment that is caused by the load as it moves across the bridge.

- Maximum bending moment caused by a single concentrated axle load occurs at center of span when load is at center of span.

- Maximum bending moment produced by a uniformly distributed load occurs at center of span when distributed load covers entire span.

- If distributed load is shorter than span, maximum bending moment occurs at center of span when center of load is at center of span.

- The following formulas are useful in determining maximum bending moments caused by single loads on simple beams:

$$M = \frac{P1}{4}$$ (Concentrated center load P)

$$M = \frac{W1}{8}$$ (Total load W uniformly distributed over span 1)

$M = w1^2$ (Load w per linear foot distributed over span 1)

$$M = W\frac{(21 - b)}{8}$$ (Load W partially distributed over span 1)

Where
- M= Moment in inch-pounds at center of beam
- P= Concentrated load in pounds
- W= Total distributed load in pounds
- w= Distributed load per linear foot in pounds
- 1= Span in inches
- b= Length of load in inches

EXAMPLES: What is the maximum bending moment produced in a 20-foot span by a single concentrated axle load of 30 tons? By a total load of 5 tons uniformly distributed over the span *(dead load)?* By a 30-ton tank that has 147 inches of track?

SOLUTIONS:

For a single concentrated axle load of 30 tons:

$$M = \frac{P1}{4}$$

Where
P= 30 tons (60,000 pounds)
1 = 20 feet (240 inches)

$$M = \frac{60{,}000 \times 240}{4} = 3{,}600{,}000 \text{ inch-pounds}$$

For a uniformly distributed load of 5 tons:

$$M = \frac{W1}{8} = \frac{10{,}000 \times 240}{8} = 300{,}00 \text{ inch-pounds}$$

For a 30-ton tank:

$$M = \frac{W(21 - b)}{8} = \frac{60{,}000\ (2 \times 240 - 147)}{8}$$

= 2,497,500 inch-pounds

- For a series of axle loads on a span, maximum moment may occur under the heaviest load when that load is at the center of the span, or it may occur under one of the heavier loads when that load and the center of gravity of all the loads on the span are equidistant from the center of the span.

- Further details on computing maximum bending moment produced by two or more loads on a span can be found in engineering handbooks.

- For the design of military bridges the computation of maximum bending produced by a series of axle loads or that produced by a uniformly partially distributed load, such as a tank, has been simplified by the use of single-axle load equivalents (SALE). The SALE is that single-axle load that, when placed at midspan, will cause the same maximum moment as the maximum moment caused by the actual vehicle. From the formula above for a concentrated center load P, and substituting SALE, we have

$$M = \frac{(SALE)\ 1}{4}$$

RESISTING MOMENT

Maximum allowable resisting moment that a beam can develop is the product of maximum allowable fiber stress for the material and section modulus of the beam, which is a measure of the capacity of the cross section of the beam to resist bending. Where M is the maximum allowable resisting moment that a beam can develop; f, the allowable extreme fiber stress for the material; and S, the section modulus, their relationship is expressed by the formula M = fS.S depends solely on shape and size of the cross section and f on the material of the beam. For rectangular beams, such as timber stringers,

$S = \frac{bd^2}{6}$, **where b and d are the breadth and depth of a section.**

For a round log,

$S = \frac{d^3}{10}$, **where d is the diameter.**

S for I-bems and other structural steel shapes may be found in tables in standard engineering handbooks. Values of S for selected I-beams and WF (wide flange) beams are given in Tables C-1 and C-2 (page 340). The stress f is ordinarily expressed in pounds per square inch, and band din inches, giving M in inch-pounds. Values of f will vary according to type of stress and type of material. For this text and the majority of field design, values as given in the next section are used. For example, if the extreme allowable fiber stress (f) in bending of the wood in a rectangular beam 6 by 12 inches is 2,400 pounds per square inch, then the maximum allowable bending moment that beam can resist is:

$$M = FS = \frac{f\ bd^2}{6} = \frac{(2400)\ (6)\ (12)\ (12)}{(6)}$$

= 345,600 inch-pounds.

Table C-1 Properties of selected American standard I-beams

DEPTH OF BEAM (in)	WIDTH OF FLANGE (in)	WEIGHT PER FOOT (lb)	SECTION MODULUS (S)* (in)
24	7⅞	106	234
24	7	80	174
20	7	81	147
20	6¼	65	117
18	6	55	88.4
15	6	61	81.2
15	5½	43	58.9
12	5¼	41	44.8
12	5	32	36.0
10	4⅝	25	24.4
8	4	18	14.2
7	3⅝	15	10.4
6	3⅜	13	7.3
5	3	10	4.8
4	2⅝	8	3.0
3	2⅜	6	1.7

*Some of these sections may not be available

Table C-2 Properties of selected wide-flange beams

DEPTH OF BEAM (in)	WIDTH OF FLANGE (in)	WEIGHT PER FOOT (lb)	SECTION MODULUS (S)* (in)
36	16½	230	836
36	12	150	503
33	15¾	200	670
33	11½	125	385
30	15	172	528
30	10½	108	299
27	14	145	403
27	10	91	233
24	14	130	331
24	12	100	249
24	9	74	170
21	13½	112	250
21	9	82	168
21	8¼	59	119
18	11¾	96	184
18	8¾	64	117
18	7½	47	82.3
16	11½	88	151
16	8½	58	94.1
16	7	36	56.3
14	14½	87	138
14	12	78	121
14	10	61	92.2
14	8	43	62.7
14	6¾	30	41.8
12	12	65	88.0
12	10	53	70.7
12	8	40	51.9
12	6½	25	30.9
10	10	49	54.6
10	8	33	35.0
10	5¾	21	21.5
8	8	31	27.4
8	6½	24	20.8
8	5¼	17	14.1

*Some of these sections may not be available

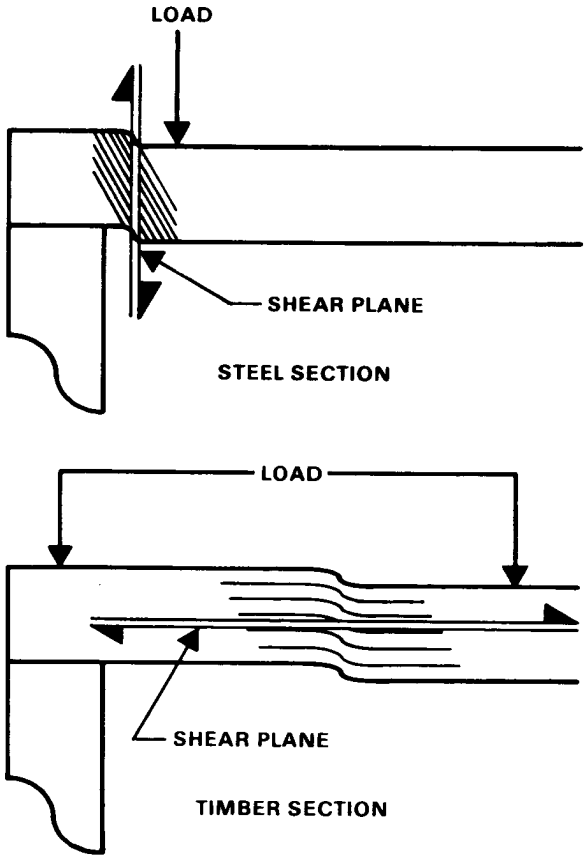


Figure C-3 Beam failure

SHEAR AND SHEARING STRESS

Any load applied to a beam induces shearing stresses. There is a tendency for the beam to fail by dropping down between the supports (Figure C-3 (A)). This is called vertical shear. There is also a tendency for the fibers of the beam to slide past each other in a horizontal direction (Figure C-3 (B)). The name given to this is horizontal shear.

The following procedures, formulas, and other data are relevant to the determination of maximum allowable shearing stress:

- For beams supported at both ends, the shear at any section (point on the beam) is equal to the reaction at one end of the beam minus all the loads between that end and the section in question. To calculate maximum shear, it is necessary to find the position of the loads that produces the greatest end reaction. This usually occurs when the heaviest load is over one support.
- In timber we find that because of the layer effect of the grain, the stringers are weaker horizontally along the member. But the stress numerically equal to the horizontal direction is numerically equal to the vertical direction, so design is on the basis of the stress in the vertical direction. In military bridge design a shear check must be made if the span length in inches is less than 13 times the depth of the stringer.
- The average intensity of shear stress (horizontal and vertical) in a beam is obtained by dividing maximum external shear by cross-sectional area of the beam. However, shear is not evenly distributed throughout the beam from top to bottom, so maximum shear intensity is greater than the average. Maximum shear intensity occurs at the midpoint of the vertical section.

- For a rectangular section, maximum horizontal shear intensity equals 3/2 times average intensity, or—$S_h = \frac{3V}{2bd}$.

  Where
  S_h = maximum shear intensity (unit shear stress) induced in the beam, in pounds per square inch
  V = maximum shear, in pounds
  b = breadth of beam, in inches
  d = depth of beam, in inches

- Over short spans where shear rather than bending may control, beams warrant special means of analysis. In computing maximum horizontal shear intensity, use the formula given above. In determining V for use in this formula, neglect all loads within a distance equal to or less than the beam height from either support, and place the design moving load at a distance three times the height of the beam from the support.

- For a circular section, maximum horizontal shear intensity equals 4/3 times average intensity, or—$S_h = 1.7 \frac{V}{d^2}$.

  Where
  d = s diameter of beam, in inches

CLASSIFICATION OF VEHICLES AND BRIDGES

The purpose of this paragraph is to outline office and field procedures for classifying vehicles and bridges in accordance with the vehicle and bridge classification system and to explain the field design of simple bridges. It explains vehicle and bridge classification procedures in sufficient detail to enable engineers who are familiar with the classification system to determine the proper classification of vehicles and bridges. It also explains how to select stringers for simple-span bridges and to design the substructure using timber trestle intermediate supports.

STANDARD CLASSES

A group of 16 standard classes ranging from 4 to 150 has been established at the intervals shown in Figure C-4 (pages 343 and 344). For each of the standard classes two hypothetical vehicles are assumed: a tracked vehicle whose weight in short tons is the standard class number, and a wheeled vehicle of greater weight which induces about the same maximum stresses in a given span. For example, in standard class 4 the tracked vehicle weighs 4 tons, the wheeled vehicle 4.5 tons; in class 8, 8 tons and 9 tons, respectively. The hypothetical vehicles and their characteristics are shown in Figure C-4. Although these vehicles are hypothetical, they approximate actual United States and United Kingdom army vehicles.

For each standard class both a moment class curve and a shear class curve are drawn. These curves are determined by computing the maximum moment and maximum shear induced in simple spans by the two hypothetical vehicles for each standard class, converting these values to single-axle-load equivalents (SALE), in short tons, and plotting the SALE against the simple-beam span in feet. The envelope curve is then drawn through the maximum moment and shear values as shown in Figures C-5 and C-6 (page 345). The standard class curves are shown in Figures C-7 through C-12 (pages 345 through 348). In computing maximum moment and shear, space the vehicles at normal convoy spacing, with an interval of 30 yards from the tail of one vehicle to the front of the next vehicle.

SPECIFICATIONS

The basic assumptions and specifications used here for design and capacity estimation data are as follows:

- As regards bending stress: steel—27,000 pounds per square inch; timber—2,400 pounds per square inch.

- As regards shear stress: structural steel sections—16,500 pounds per square inch; steel pins and rivets—20,000 pounds per square inch; timber—150 pounds per square inch.

- As regards impact: steel—15 percent of live load moment; timber—none.

- As regards the lateral distribution factor theoretically, two stringers are twice as strong as one, four are twice as strong as two, and so on; actually, this is true only if

each stringer carries an equal share of the total load. A stringer directly under a wheel load is more highly stressed and carries a greater portion of the load than those farther to the side. Because of this nonuniform lateral distribution of a wheel load among stringers, the total width (or number) of stringers required to carry a particular load is greater than the total width (or number) that would be required if all stringers carried an equal share of the load. This requires an increase in stringer width (or number of stringers) and is expressed as a ratio called lateral distribution factor. For design of two-lane military bridges with vehicles on the centerline of each lane, the factor is 1.5.

- As regards roadway widths: a minimum clear width between curbs of 13 feet 6 inches for single-lane bridges and 22 feet for two-lane bridges.
- As regards the distance between road contacts of vehicles following in line: 100 feet.

OFFICE DETERMINATION

Use the following method to determine vehicle class number in the office:

1 Compute the maximum moment produced by the vehicle in at least six simple spans of different length.

2 Convert maximum moment to SALE using the formula, $\mathbf{SALE} = \frac{\mathbf{4M}}{\mathbf{L}}$, in which M = maximum moment in foot-tons, and L = span length in feet.

3 Plot SALE against corresponding span length.

4 Draw curve through the points plotted. This is the moment class curve for the vehicle.

5 Superimpose the curve over the standard class curves for moment (Figures C-7, C-8, and C-9).

6 Determine the class of the vehicle by the position of the vehicle class curve with respect to the standard class curves. Round off any fraction to the next larger whole number.

Repeat the last three steps for maximum shear, using the formula, SALE = shear.

The class of the vehicle is the maximum class determined from either the moment or shear curve. In most cases, moment will govern.

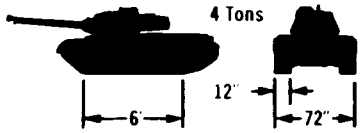
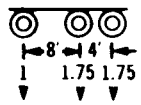
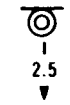
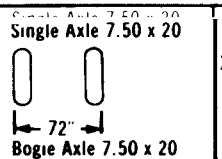
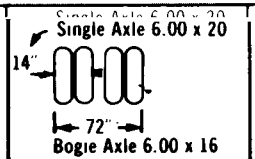
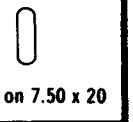
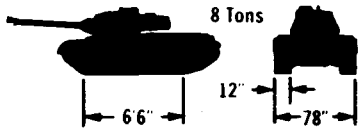
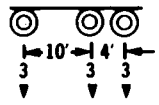
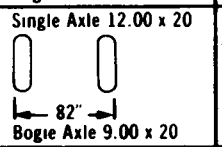
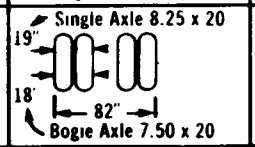
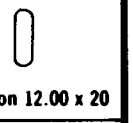
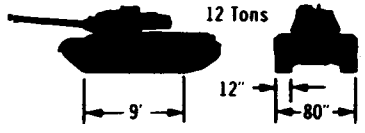
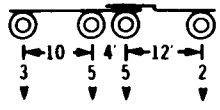
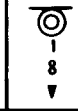
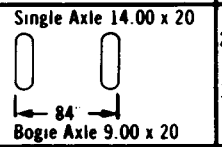
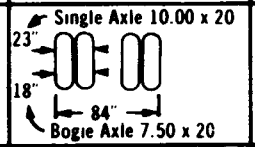
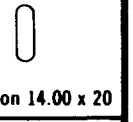
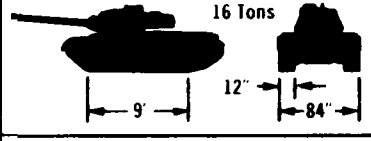
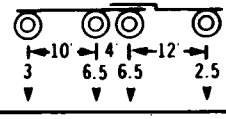
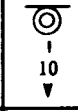
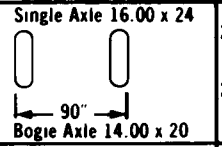
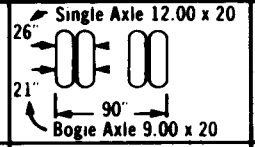
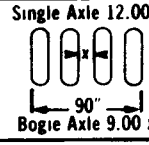
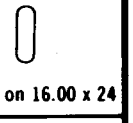
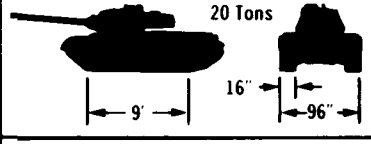
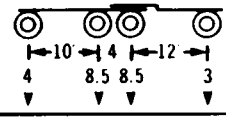
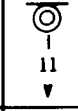
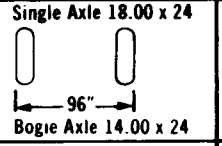
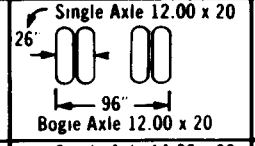
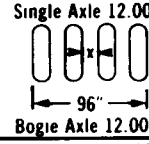
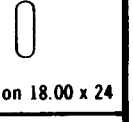
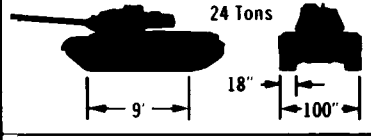
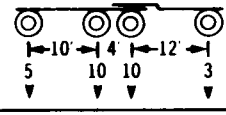
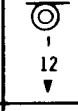
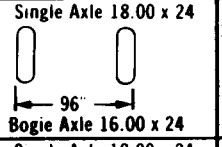
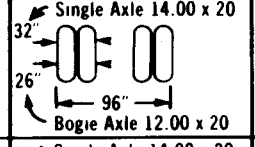
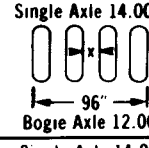
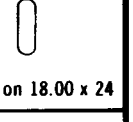
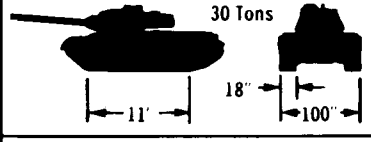
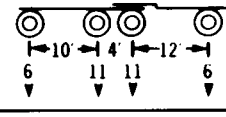
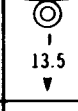
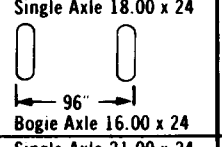
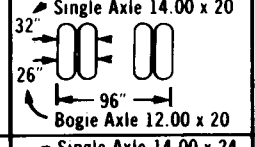
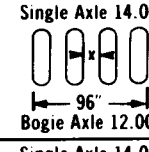
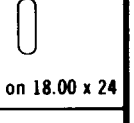
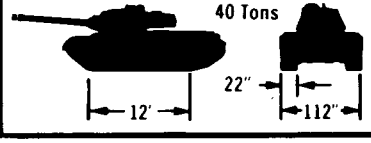
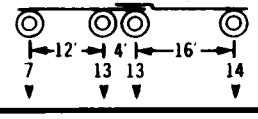
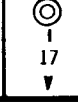
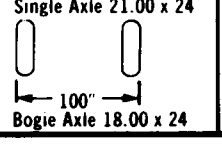
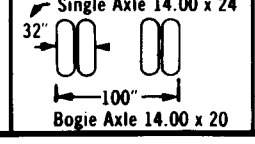
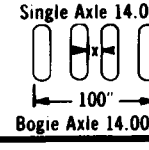
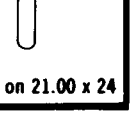
CLASS	TRACKED VEHICLES	WHEELED VEHICLES: AXLE LOAD AND SPACING	MAX SINGLE AXLE	MINIMUM WHEEL SPACING AND TIRE SIZES OF CRITICAL AXLES			CRITICAL TIRE LOAD AND TIRE SIZE
4						Note: Spacing between center tires: x' equals tire width	
8							
12							
16							
20							
24							
30							
40							

Figure C-4 ***Standard class, hypothetical vehicles, and vehicle characteristics***

CLASS	TRACKED VEHICLES	WHEELED VEHICLES: AXLE LOAD AND SPACING	MAX SINGLE AXLE	MINIMUM WHEEL SPACING AND TIRE SIZES OF CRITICAL AXLES			CRITICAL TIRE LOAD AND TIRE SIZE
50	50 Tons 13' 26" 128"	58 Tons 12' 4 16' 8 15 15 20	20	Single Axle 24.00 x 29 112" Bogie Axle 21.00 x 24	Single Axle 16.00 x 24 37" 32" 112" Bogie Axle 14.00 x 20	Single Axle 16.00 x 24 112" Bogie Axle 14.00 x 20	20.000# on 24.00 x 29
60	60 Tons 14' 28" 132"	70 Tons 12' 5' 15' 4' 8 18 18 13 13	23		Single Axle 18.00 x 24 41" 37" 128" Bogie Axle 16.00 x 24	Single Axle 18.00 x 24 128" Bogie Axle 16.00 x 24	20.000# on 24.00 x 29
70	70 Tons 15' 31" 138"	80.5 Tons 12' 5' 15' 4' 12 24 24 14 14	25.5		Single Axle 18.00 x 24 41" 37" 132" Bogie Axle 16.00 x 24	Single Axle 18.00 x 24 132" Bogie Axle 16.00 x 24	20.000# on 24.00 x 29
80	80 Tons 16' 33" 144"	92 Tons 12' 5' 18' 5' 12 24 24 16 16	28		Single Axle 21.00 x 24 49" 41" 138" Bogie Axle 18.00 x 24	Single Axle 21.00 x 24 138" Bogie Axle 18.00 x 24	20.000# on 24.00 x 29
90	90 Tons 17' 35" 150"	103.5 Tons 12' 5' 18' 5' 13.5 27 27 18 18	30		Single Axle 21.00 x 24 49" 41" 138" Bogie Axle 18.00 x 24	Single Axle 21.00 x 24 138" Bogie Axle 18.00 x 24	20.000# on 24.00 x 29
100	100 Tons 18' 37" 154"	115 Tons 12' 6' 20' 5' 15 30 30 20 20	32		Single Axle 21.00 x 24 49" 41" 144" Bogie Axle 21.00 x 24	Single Axle 21.00 x 24 144" Bogie Axle 21.00 x 24	20.000# on 24.00 x 29
120	120 Tons 20' 40" 168"	138 Tons 12' 6' 20' 5' 18 36 36 24 24	36			154" Bogie Axle 24.00 x 29	20.000# on 24.00 x 29
150	150 Tons 24' 50" 190"	170 Tons 12' 7' 22' 6' 22 42 42 32 32	42			160" Bogie Axle 24.00 x 29	21.000# on 24.00 x 29

Figure C-4 ***Standard class, hypothetical vehicles, and vehicle characteristics****—continued*

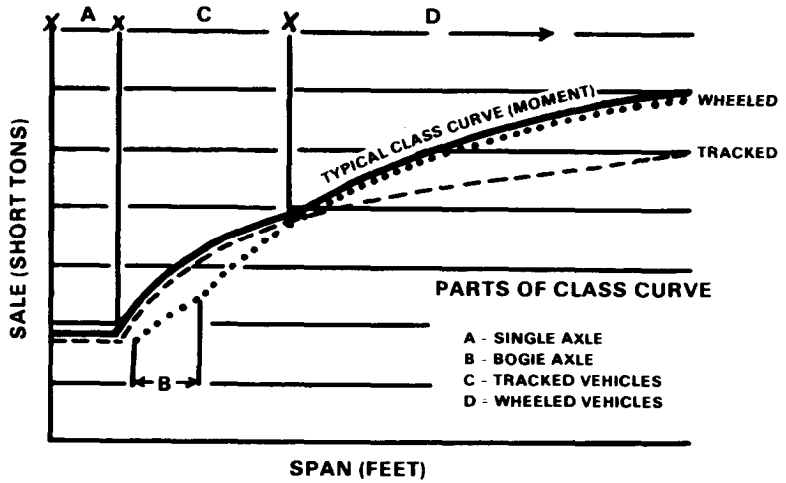


Figure C-5 ***Typical standard class curve*** *(moment)*

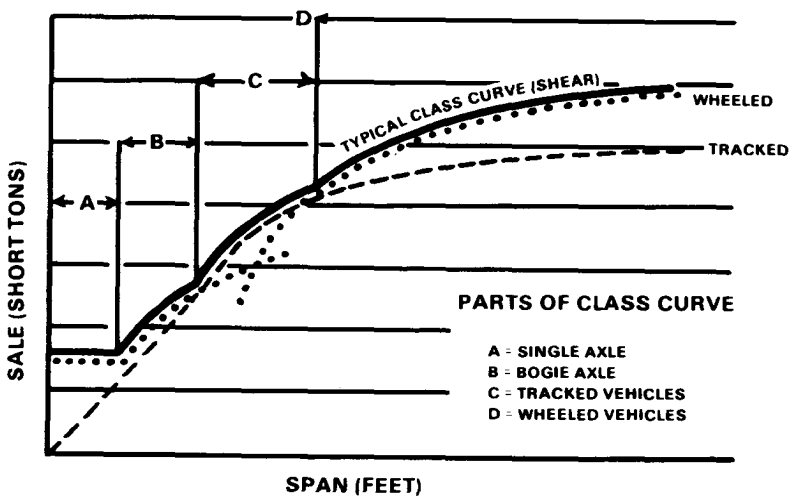


Figure C-6 ***Typical standard class curve*** *(shear)*

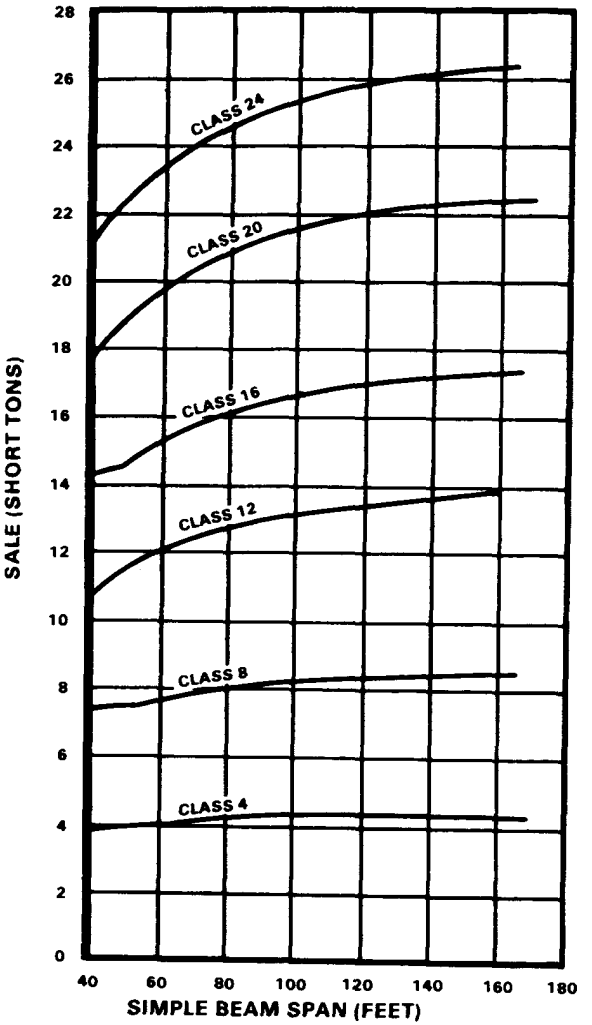


Figure C-7 ***Standard class curves (moment), 4 to 24***

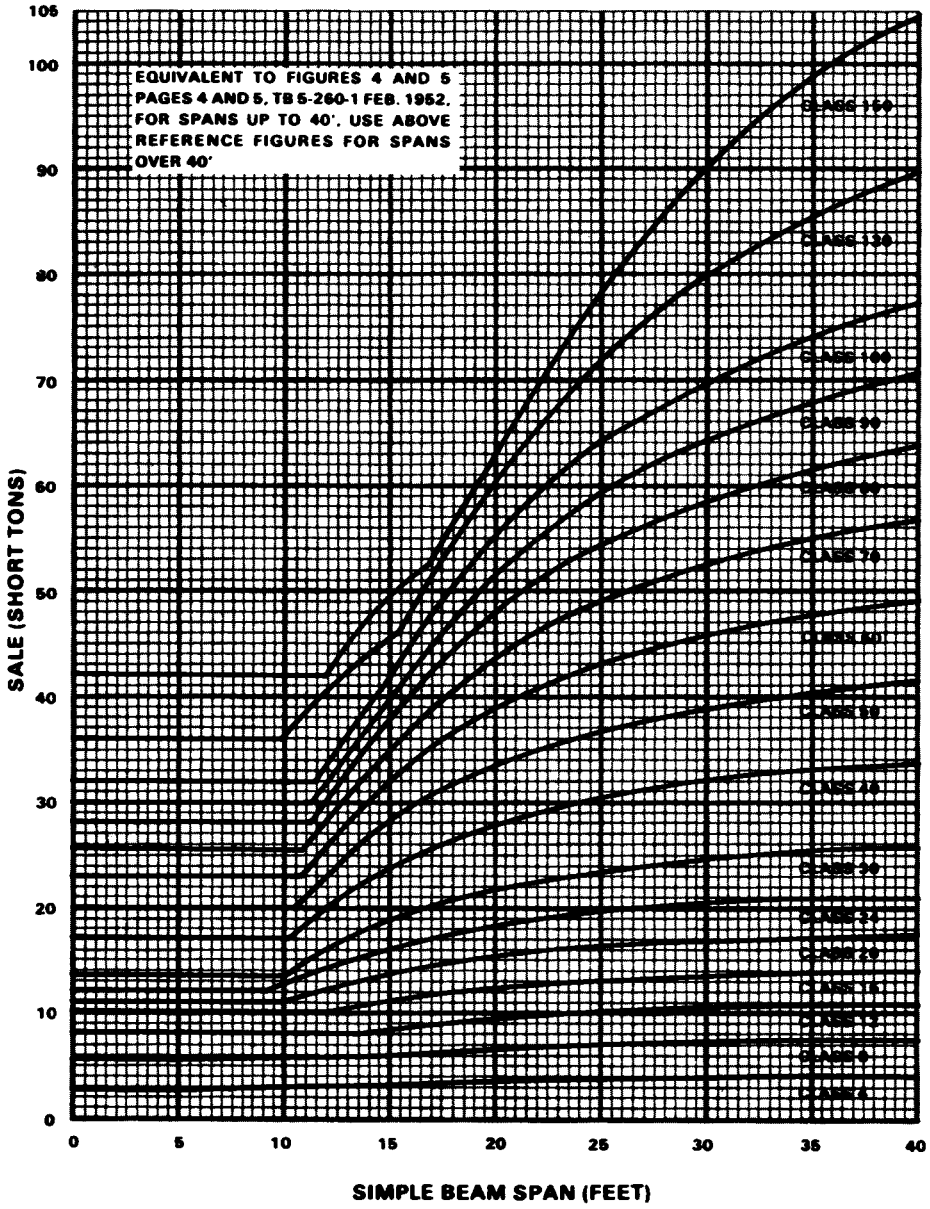


Figure C-8 Standard class curves (moment), 4 to 150 (span 5 to 40)

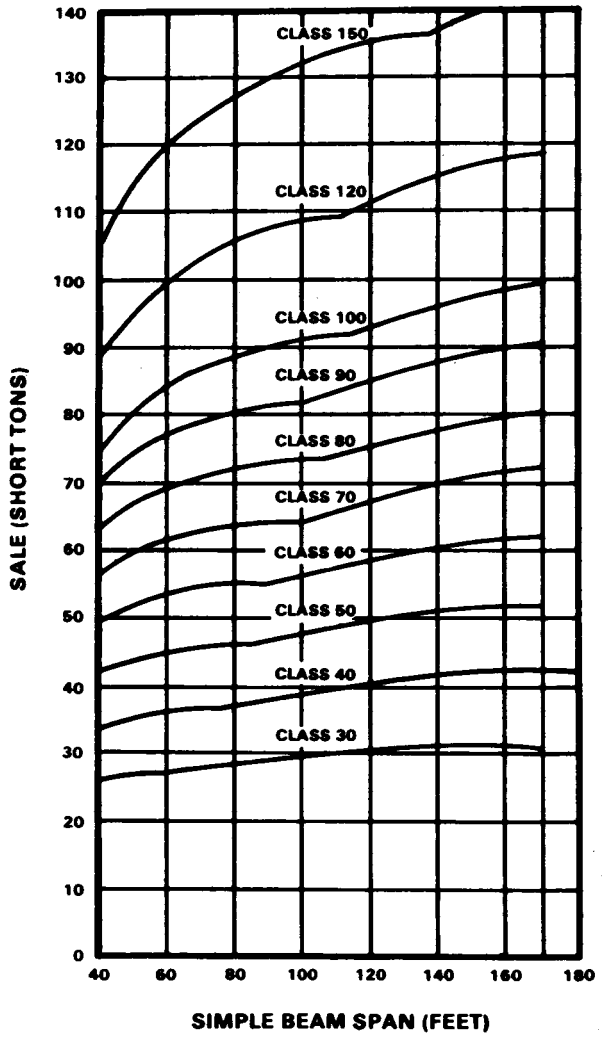


Figure C-9 Standard class curves (moment), 30 to 150

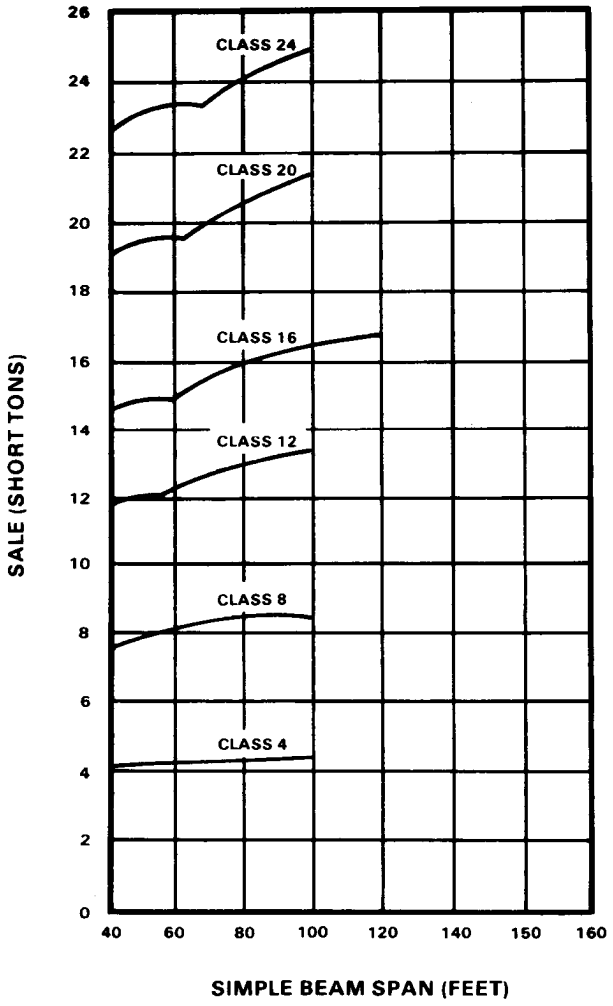


Figure C-10 ***Standard class curves (shear), 4 to 24***

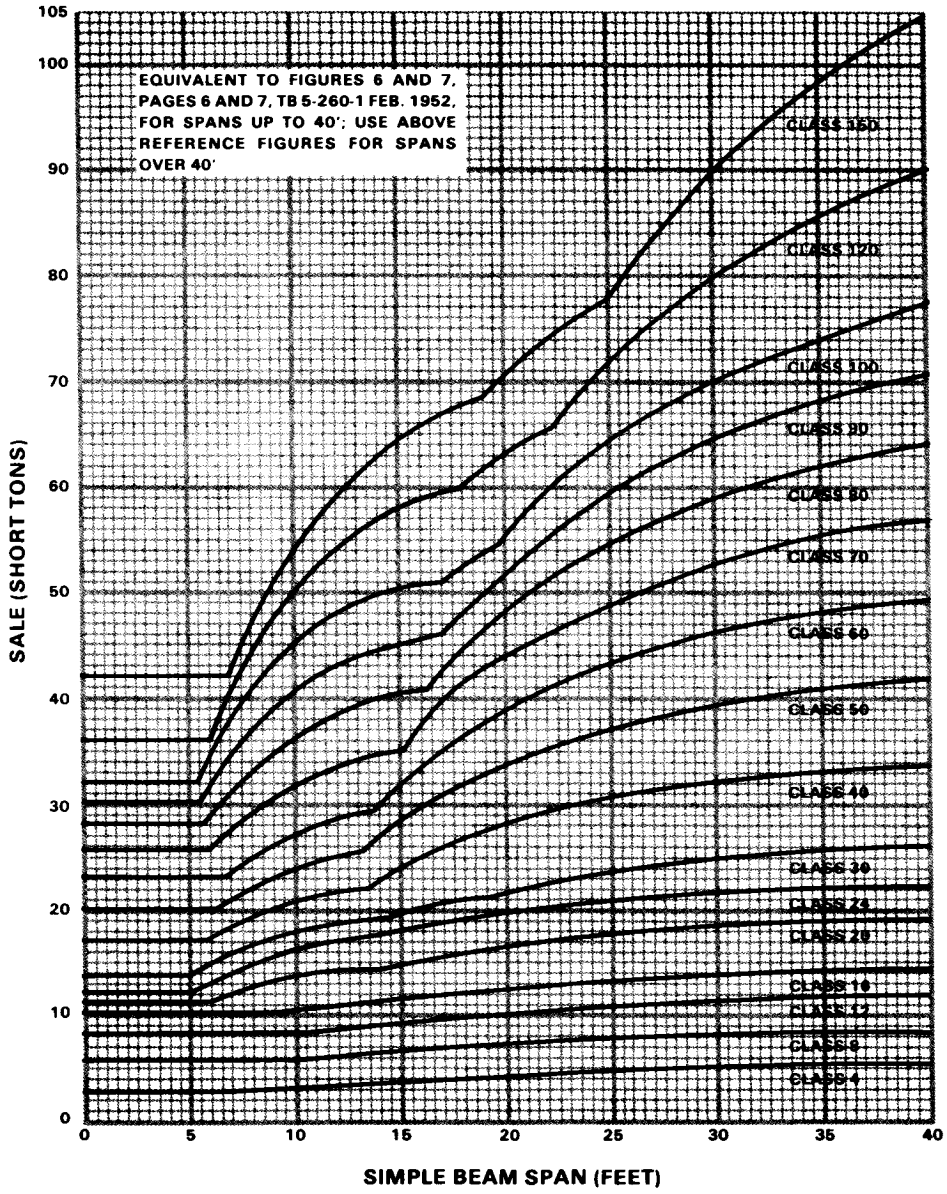


Figure C-11 ***Standard class curves (shear), 4 to 150 (span 5 to 40)***

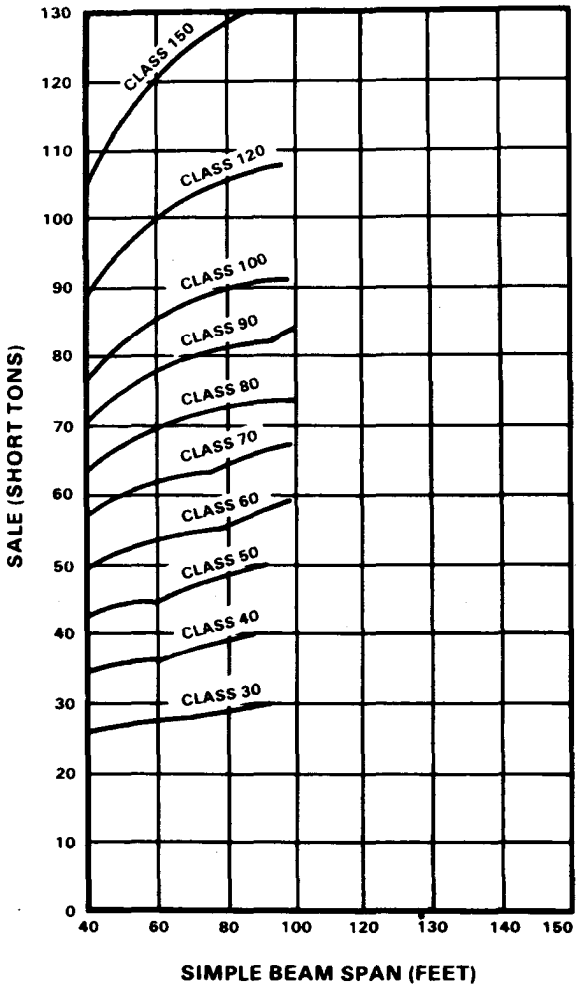


Figure C-12 ***Standard class curves (shear), 30 to 150***

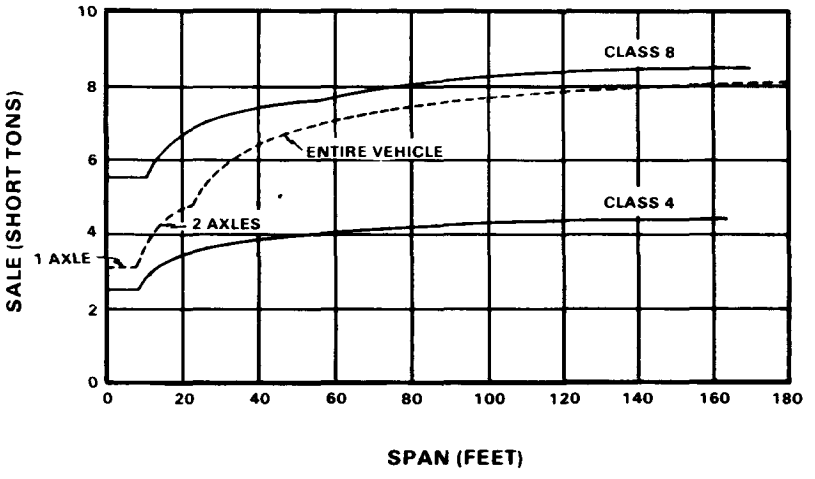


Figure C-13 ***Moment curve for 2½-ton truck, 6x6, dump, LWB***

EXAMPLES:

Single vehicle

Figure C-13 shows the moment curve for a 2 1/2-ton, 6x6 dump truck superimposed on the standard class curves. From the figure it is seen that the curve for this vehicle lies between the class 4 and the class 8 curves and from its position with respect to these curves the vehicle is class 8.

Combination vehicle over class 40

Figure C-14 shows the moment curve for a M26A1 tractor with transporter M15A1, loaded, superimposed on the standard class curves. From the figure it is seen that at a span length of 100 feet the superimposed curve crosses the standard class 70 curve and begins to level off. It does not cross the class 80 curve. From its position with respect to the standard class curves, the class of the vehicle is 77. Figure C-14 shows that the vehicle has lower classes at shorter span lengths. At a span length of 70 feet, for example, the vehicle's class curve crosses the standard class 60 curve, and for this span the class of the vehicle is 60. The other classes of the vehicle for shorter span lengths are similarly determined by inspection of the curves, and this information is placed on a cab plate. The section of the cab plate for this vehicle, loaded, shows the class restrictions for the various spans, listed in Table C-3.

FIELD DETERMINATION

If time, information, or a qualified engineer is unavailable, and the office methods cannot be used, substitute one of the following methods:

- Compare characteristics such as dimensions, axle loads, and gross weight with characteristics of the hypothetical vehicles shown in Figure C-4.

EXAMPLE:

An unclassified wheeled vehicle has a gross weight of 27 tons and a length of about 27 feet. By interpolation in Figure C-4, it is class 23. If, however, because of

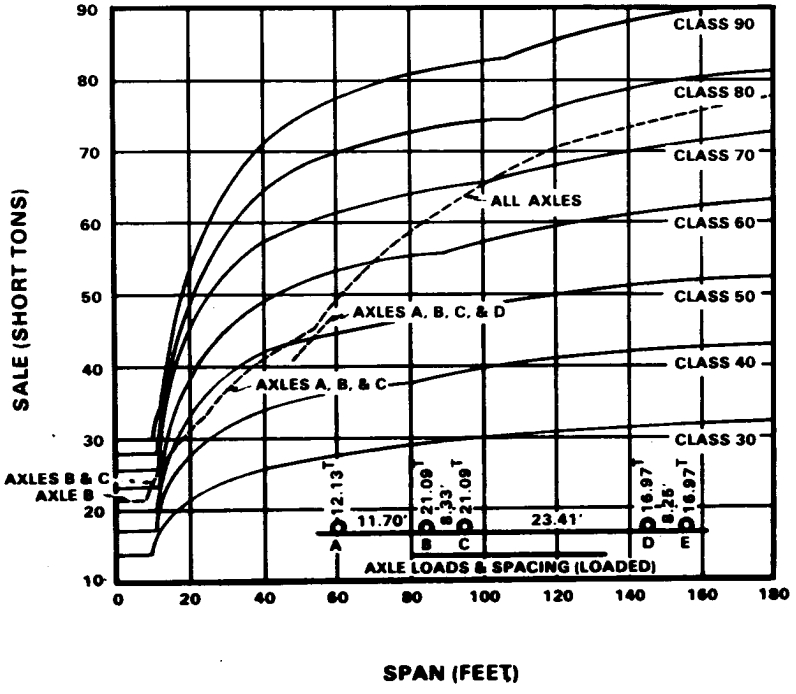


Figure C-14 Moment curve for M26A1 tractor, with transporter, M15A1, loaded

axle spacing and weight distribution the maximum single-axle load for this vehicle is 12.5 tons (greater than Figure C-4 shows as allowable for class 23), the maximum single-axle load is used as the classifying criterion. By interpolation in the maximum single-axle load column (Figure C-4), the vehicle is then class 26.

- Compare the characteristics of an unclassified vehicle with those of a similar classified vehicle.

EXAMPLE:
An unclassified single vehicle has three axles, is about 166 inches long, and weighs about 8 1/2 tons. By comparison with a standard 2 1/2-ton truck 6x6-LWB, which weighs 8.85 tons, it is class 8.

Compare the ground-contact area of an unclassified tracked vehicle with that of a classified tracked vehicle. Tracked vehicles can be assumed to be designed with about the same ground pressure.

Table C-3 Class restrictions of various spans for M26A1 tractor, with transporter, M15A1, loaded

SPAN (ft)	CLASS
0 to 9	60
9 to 12	70
12 to 16	60
16 to 38	50
38 to 70	60
70 to 100	70
100 and over	77

EXAMPLE:
An unclassified tracked vehicle has a ground contact area of about 5,500 square inches. By comparison with an M4 tank, which has a ground contact area of 5,444 square inches, it is class 36.

- Compare the deflection in a long steal span caused by an unclassified vehicle with the deflections caused by classified vehicles. In this method the span must be at least twice as long as the vehicles and the vehicles must be placed for maximum deflection. Measuring apparatus must be accurate to at least one thirty-second of an inch.

EXAMPLE:
Select two vehicles of known class which are estimated to bracket the unknown vehicle class. Measure the deflections of a long steel span when loaded individually by each of the three vehicles. Move each vehicle on the span three times and read the deflection. Then average the three readings.

Vehicle	*Class*	*Deflection (average of three loadings)*
A	62	2 13/32 in, or 2.406in
B	42	1 11/16 in, or 1.688 in
C	unknown	2 3/32 in, or 2.094 in

Class is considered proportional to deflection so—

Unknown class = lower class + (Upper class–lower class) x deflection of unknown class minus deflection of lower class

Deflection of upper class minus deflection of lower class

$$= 42 + \left[20 \left(\frac{2.094\text{-}1.688}{2.406 - 1.688}\right)\right]$$

$$= 42 + \left[20 \left(\frac{0.406}{0.718}\right)\right]$$

= 42+ 11.31 = 53.31, or class 53

GLOSSARY
ACRONYMS AND ABBREVIATIONS

A	anchor span
AR	as required
assy	assembly
B	bridge
BP	base plate
BSS	British standard specification
C	cantilever span, caution
C-C	center to center
cad pltd	cadmium plated
circ	circular
℄	centerline
cm	centimeter(s)
d	distance from center of gravity to tail of bridge
DD	double-double
diam	diameter
DL	dead load
DQ	double-quadruple
DS	double-single
DT	double-triple
D5	double-five stories
ETO	European theater of operations
FS	far shore, foot, feet
gal	gallon(s)
H	horizontal
hex (hd)	hexagonal (head)
hr	hour
hyd	hydraulic, impact
in	inch(es)
L	length of bridge
l	length of span of bridge
lb	pound(s)
lg	long
LH	left-handed
Li	length, initial
LL	live load
LR	lift required
max	maximum
mess	measure
min	minimum
Mk	Mark (model)
MOPP	mission-oriented protection posture
mph	miles per hour
N	normal, nose
NATO	North Atlantic Treaty Organization
no	number
NPT	national pipe thread
NPTF	national pipe thread fine
NS	near shore
pcs	pieces
P	panel
PL	
pt	point
QD	quadruple-double
QS	quadruple-single
QT	quadruple-triple
qty	quantity
R	risk, rocking roller
ref	reference
reinf	reinforced
RH	right-handed
RRT	rocking-roller template
S	simple suspended span
SALE	single-axle-load equivalent(s)
SBC	soil-bearing capacity
sq	square
SS	safety setback, single-single
T	tracked-load class
t/sf	tons per square foot
TD	triple-double
thd	thread
TS	triple-single
TT	triple-triple
T5	triple-five stories
T6	triple-six stories
V	vertical
W	wheeled-load class, wide-flange beam (formerly WF)
w	with
wo	without
wt	weight
yd	yard(s)

DEFINITIONS

Angle of repose — For field design, assumed to be an angle of 45 degrees from the horizontal. The base of this angle starts at the toe of slope and proceeds upward to ground level. Placement of any load in front (toward the gap) of this angle would probably result in bank failure.

Backspace — The amount of space available for construction of the bridge.

Bailey bridge Ml — The original US design of the British prefabricated Bailey bridge.

Bailey bridge M2 — The revised US design of the Bailey bridge Ml, with a greater roadway width of 121/2 feet. Also called the Panel Bridge.

Bailey bridge M3 — The revised, wider, British design of the Bailey bridge M2. It is often referred to as the extra-widened Bailey bridge and is not stocked by the US Army.

Bay — One complete section of a Bailey bridge, equivalent to the length of one panel 10 feet (3.04 meters) wide. The term bay is used regardless of the truss type.

Bays — ***Floating:*** Interior bays of a floating bridge that are located between the near- and far-bank end floating bays.
End Floating: Those which form the continuation of the bridge between the floating and the landing bays.
Landing: Those which form the connection between the end floating bay and the bank. There are two types:
Variable-slope - these span the gap between the bank and the landing bay, or the intermediate landing bay if a fixed-slope landing bay is used.
Fixed-slope - these span the gap between the intermediate landing bay and the landing bay.

Beam, distributing — ***Rigid:*** A steel beam securely attached to the top of a pier or abutment which is designed to spread the weight applied to it over a large area.
Rocking-bearing: A steel beam attached to the bottom chord of Bailey bridge panels. It is used to prevent excessive local bending of the bottom chord.

Blocking — Timber used to support the junction of the first and second bays of bridge when building deck-type bridges without end posts. Also, any timber used under girders during jacking down of deck-type bridges.

Bridge

Through-type truss: A bridge with a roadway between the main load-carrying girders.
Deck-type: A bridge with the roadway on top of the main load-carrying girders.
Broken-span: A multispan bridge with the top chord broken and the bottom chord either broken or pinned at the piers.
Continuous-span: A bridge of which both upper and lower chords are continuous over intermediate piers between abutments.

Chords

The upper and lower horizontal members of a Bailey panel.

Cribbing

Grillage placed in alternating layers under the roller templates and bridge baseplates to provide the correct horizontal plane on which the bridge is built, launched, and positioned for trafficking.

Decking

Laminated: Timbers laid on edge and nailed together horizontally, and then positioned on top of Bailey panels to form a type of roadway for deck-type bridges.
Layered: Roadway on deck-type bridges comprised of timbers laid across the trusses perpendicular to the bridge centerline. The second layer is placed diagonally to the first, and a third layer (optional wear tread) is placed parallel to centerline. Sometimes referred to as deck, or flooring.

Grillage

Standard: Square-cut timber positioned under the Bailey bridge to spread the weight of the ridge over a large area. The Bailey grillage set has a fixed number of two sizes of standard grillage.
Non-standard: Timber other than that supplied in the Bailey set. This timber must be at least as large as standard Bailey grillage.

Harmonious vibration

Vibration in a bridge caused by the loads crossing it.

Node points

Critical-load centering points used for exact alignment of components bearing on each other.

Packing

Timber used during raising and lowering, which the bridge rests on while jacks are repositioned.

Panel bridge

See **Bailey bridge M2.**

Panel points

Points under panel verticals and junctions of diagonals that must be supported by a rocker-bearing distributing beam.

Pier	***Floating-bay:*** Supports the floating bay in the interior of the Bailey bridge. ***Landing-bay:*** Supports the shore end of the floating bay and riverward end of either the fixed-slope or the variable-slope landing bay. ***Intermediate landing-bay:*** Supports the shore end of the fixed-slope landing bay and the riverward end of the variable-slope landing bay.
Placement control lines	Used to ensure that the rollers are placed and leveled accurately.
Point of contraflexure	The point where the downward sag of a girder changes to an upward bend as it approaches an intermediate support.
Roller clearance	The distance between the center of the rocking rollers and the center of the bearing on which the bridge end posts will rest.
Safety setback	The minimum distance that a rocking roller is placed from the edge of the gap.
Skidding	Moving the bridge or a single girder over greased timbers or steel beams.
Spacing	***Lateral:*** Spacing of the rollers in rows across the centerline of the bridge. ***Longitudinal:*** Spacing of the rollers in a line parallel to the centerline of the bridge.
Span	***Lift:*** Connects two adjacent floating bays and provides a span that can be lifted vertically to allow passage of water traffic. ***Draw:*** Connects two adjacent floating bays and provides a span that can be split in the middle and the two parts pivoted upward to allow passage of water traffic. ***Connecting:*** Connects two adjacent floating bays where barges are grounded.
Supplementary chords	Upper or lower chords used to reinforce a Bailey bridge.
Temporary launching pier	A pier used during the building of bridges with an underslung story.
Toe of slope	The point in the gap considered to be the base of the bank.
Underslung story	One story of a through-type truss bridge that is below the level of the roadway.
Wear tread	Lumber laid across the chess of the Bailey bridge to prevent damage by vehicles crossing it.

REFERENCES
REQUIRED PUBLICATIONS

These are sources that users must read in order to understand or comply with this publication.

Department of the Army Pamphlet (DA Pamphlet)

736-750	The Army Maintenance Management System (TAMMS)

Field Manuals (FMs)

5-34	Engineer Field Data
5-134	Pile Construction

Tables of Organization and Equipment (TOEs)

05077H200	Engineer Panel Bridge Company
05077J200	Engineer Panel Bridge Company

Technical Manuals (TMs)

5-312	Military Fixed Bridges
9-2320-260-10	Operators Manual for Truck, 5-Ton, 6 x 6, M809 Series (Diesel)
9-2320272-10	Operators Manual for Truck, 5-Ton, 6 x 6, M939 Series (Diesel)
9-2330-287-14&P	Operator's, Organizational, Direct Support and General Support Maintenance
740-90-1	Administrative Storage of Equipment
750-244-3	Procedures for Destruction of Equipment to Prevent Enemy use

RELATED PUBLICATIONS

These are sources of additional information. They are not required in order to understand this publication.

Department of the Army Form (DA Form)

2258	Depreservation Guide for Vehicles and Equipment

Federal Supply Group (FSG)

9100	Identification List (IL): FSG 9100, Fuels, Lubricant, Oils, and Waxes

Field Manuals (FMs)

5-1	Engineer Troop Organizations and Operations
5-25	Explosives and Demolitions
5-36	Route Reconnaissance and Classification
55450-1	Army Helicopter External Load Operations
101-5-1	Operational Terms and Symbols

Lubrication Order (LO)

9-2320-260-12	Truck Chassis 5-ton, 6 x 6, M809

Technical Manuals (TMs)

5-210	Military Floating Bridge Equipment
5-232	Elements of Surveying
36-230-1	Packaging of Materiel: Preservation (Vol I)
43-0139	Painting Instructions for Field Use

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FM 5-277
9 MAY 1986

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General United States Army
The Adjutant General

DISTRIBUTION:

Active Army, USAR, and ARNG: To be distributed in accordance with DA Form 12-34B, Requirements for Bailey Bridge (Qty rqr block no. 658).

☆ U.S. GOVERNMENT PRINTING OFFICE 1994-367-927

APPENDIX A

OVERSIZED TABLES

Pages 297.1 through 322

Table A-1 ***Parts needed (and their quantities) for Bailey bridges***

TRUSS CONSTRUCTION			SS		DS					TS				DD				TD					DT					TT				
CLASS	WHEELED LOAD		30	24	75	65	60	50	40	85	65	50	35	80	65	45	35	90	75	55	45	35	70	70	60	55	45	35	80	70	55	45	35
	TRACKED LOAD		30		70	65	60	55	45	80	65	55	40	80	70	55	45	90	80	60	55	45	80	70	60	55	50	45	75	70	60	55	40
SPAN (ft)			30	40	50	60	70	80	90	80	90	100	110	100	110	120	130	110	120	130	140	150	130	140	150	160	170	180	160	170	180	190	200
ITEMS	UNIT WEIGHT (lbs)	SPARES INCLUDED																															
Bearer, footwalk	23	2 or 4	16	20	24	28	32	36	40	32	40	46	50	46	50	54	58	50	54	58	62	66	58	62	66	70	74	78	70	74	78	82	86
Bearing	68		4	4	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Bolt, bracing B	1	25%	20	25	80	95	110	125	140	170	190	210	230	265	290	315	340	400	435	470	505	540	480	515	550	585	620	655	820	870	920	970	1,020
N			10	15	15	20	20	25	30	25	30	30	35	30	35	35	40	30	35	60	70	85	70	70	85	100	100	100	175	190	230	245	295
Bolt, chord B	7.5	10%												88	97	106	114	145	158	172	185	198	286	308	330	352	374	396	493	524	554	585	616
N																															18	18	35
Bolt, ribband, guardrail, J	4.5	10%	62	70	79	88	97	106	114	106	114	123	132	123	132	141	150	132	141	150	158	167	150	158	167	176	185	194	176	185	194	202	211
Brace, sway, M2 B	68	10% to 4 max	7	9	11	13	15	18	20	18	20	22	24	22	24	26	29	24	26	29	31	33	54	58	62	66	70	74	66	70	74	78	82
N			2	4	4	7	7	9	11	9	11	11	13	11	13	13	15	11	13	15	15	18	15	15	18	20	20	20	31	33	37	40	44
Chess, M2	65	10% to 20 max	100	114	129	143	157	172	186	172	186	200	215	200	215	228	241	215	228	241	254	267	241	254	267	280	293	306	280	293	306	319	332
Clamp, transom B	7	10% to 20 max	15	20	99	57	65	73	81	212	125	134	147	180	99	108	117	296	308	174	187	200	236	125	134	143	152	161	416	226	238	250	262
N			4	7	7	9	9	11	13	11	13	13	15	13	15	15	18	13	15	22	24	29	24	24	29	33	33	33	55	59	66	70	79
Clip, retainer B	0.13	25% to 70 max	20	25	60	70	80	90	100	135	150	165	180	210	230	250	270	345	370	394	418	442	382	406	430	454	478	502	646	682	718	754	790
N			6	10	10	15	15	20	25	20	25	25	30	25	30	30	35	25	30	35	40	50	40	40	50	60	60	60	100	110	125	135	175
Footwalk	104	2	8	10	12	14	16	18	20	18	20	22	24	22	24	26	28	24	26	28	30	32	28	30	32	34	36	38	34	36	38	40	42
Frame, bracing B	44	10%			11	13	15	18	20	18	20	22	24	46	51	55	59	51	55	59	67	68	90	90	103	110	117	123	110	117	123	130	136
N																				4	7	9	7	7	9	11	11	11	22	24	31	33	42
Panel B	577	10% to 10 max	7	9	22	26	31	35	40	53	59	66	73	88	97	106	114	142	154	166	178	190	166	178	190	202	214	226	298	316	334	352	370
N			4	7	7	9	9	11	13	11	13	13	15	13	15	15	18	13	15	22	24	29	24	24	29	33	33	33	55	59	75	79	97
Pedestal, ramp, M2	93		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Pin, panel B	6.1	20% to 50 max	19	24	58	67	77	86	96	110	125	139	154	202	221	240	259	302	326	350	374	398	362	386	410	434	458	482	602	638	673	710	746
N			5	10	10	14	14	19	24	19	24	24	29	24	29	29	34	24	29	34	38	48	38	38	48	58	58	58	96	106	120	130	168
Pin, panel, short	5.8									16	16	16	16					24	24	24	24	24							24	24	24	24	24
Plate, base	381		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Plate, tie	3.5	10%								20	22	24	26					48	53	57	62	66							103	110	117	123	130
Post, end, female	130	2	4	4	6	6	6	6	6	8	8	8	8	6	6	6	6	8	8	8	8	8	6	6	6	6	6	6	8	8	8	8	8
Post, end, male	121	2	4	4	6	6	6	6	6	8	8	8	8	6	6	6	6	8	8	8	8	8	6	6	6	6	6	6	8	8	8	8	8
Post, footwalk	10	10% to 4 max	15	20	24	29	33	37	42	37	42	46	50	46	50	54	58	50	54	58	62	66	58	62	66	70	74	78	70	74	78	82	86
Raker B	22	10%	9	11	13	15	18	20	22	20	22	24	26	24	26	29	31	26	29	31	33	35	31	33	35	37	40	42	37	40	42	44	46
N			4	7	7	9	9	11	13	11	13	13	15	13	15	15	18	13	15	18	18	20	18	18	20	22	22	22	33	35	40	42	46
Ramp, button	348		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Ramp, plain	338		16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Ribband, guardrail, steel	162		14	16	18	20	22	24	26	24	26	28	30	28	30	32	34	30	32	34	36	38	34	36	38	40	42	44	40	42	44	46	48
Rope, handrail, ⅜" x 150'	20		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	4	2	2	4	4	4	4	4	4	4	4	4
Stringer, button	267	10%	7	9	11	13	15	18	20	18	20	22	24	22	24	26	29	24	26	29	31	33	29	31	33	35	37	40	35	37	40	42	4
Stringer, plain	260	10% to 4 max	13	18	22	26	31	35	40	35	40	44	48	44	48	52	56	48	52	56	60	64	56	60	64	68	72	76	68	72	76	80	84
Support, overhead-bracing	150	10% to 4 max																					29	31	33	35	37	40	35	37	40	42	44
Transoms, M2 B	618	10% to 4 max	9	11	23	15	18	20	22	37	22	24	26	45	26	29	31	50	54	31	33	35	70	48	51	54	57	60	86	57	60	63	66
N			2	3	3	4	4	6	7	6	7	7	8	7	8	8	9	7	8	9	9	10	9	9	10	11	11	11	17	18	20	21	23

Notes:
B = bridge
N = nose

CRITICAL DIMENSIONS

Road width between steel ribbands	12'6"
Road width between timber truss guards	13'9"
Lateral distance between centerlines of trusses:	
inner trusses	14'10"
middle trusses	17'10"
outer trusses	19'3"
Lateral distance between centerlines of base plates:	
S-truss bridge	14'10"
D-truss bridge	16'4"
T-truss bridge	17'3½"
Lateral distance between outside edges of base plates:	
S-truss bridge	19'5"
D-truss bridge	20'11"
T-truss bridge	21'10½"
Lateral distance between measuring lugs of rocking-roller templates	11'6½"
Lateral distance between measuring lugs of plain-roller templates:	
SS, DS bridges	11'6½"
TS, DD, TD, DT, TT bridges	10'10½"
Longitudinal spacing between plain rollers	25'
Height from base of base plate to top of chess	28 5/16"
Height from base of rocking-roller template to top of rocking-roller	16 5/16"
Height from base of plain-roller template to top of plain roller	8 15/16"
Height from base of ramp pedestal to top of ramp chess	17¼"
Height from bottom of half round lug under sloping end of ramp to top of ramp chess	5⅞"
Height from top of chess to overhead bracing:	
normal	14'7"
expedient	12'3"
Height from base of bearing to bottom of panel	5 17/32"
Height from bottom of panel to top of chess	20 11/16"
Height from bottom of half round lug of end post to top of chess	22 13/32"
Height from base of rocking-roller bearing to top of rocking roller	13 5/16"

TYPES OF CONSTRUCTION

LAUNCHING CONSTRUCTION

		SPAN (ft)	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
SS	Bays in nose	SS	2	3	3	4	5	5	6	6[1]											
		DS																			
		DD																			
	Distance of links from tip of nose (ft)					10	20	20	30	30											
	Required distance behind rocking rollers (ft)		35	43	47	55	63	67	75	76											
DS	Bays in nose	SS			3	4	4	5	6	6	7	8	8	8[1]							
		DS																			
		DD																			
	Distance of links from tip of nose (ft)					10	10	20	20	20	30	40	10[2]	10[2]							
	Required distance behind rocking rollers (ft)				45	52	57	64	71	76	83	90	95	96							
TS	Bays in nose	SS						5	6	6	7	7	8	9	9[1]	9[1]					
		DS																			
		DD																			
	Distance of links from tip of nose (ft)							20	20	20	30	30	40	10[2]	20[2]	20[2]					
	Required distance behind rocking rollers (ft)							63	70	74	81	86	93	100	101	106					
DD	Bays in nose	SS								6	7	7	8	7	6	6[1]	7[1]	7[1]			
		DS												2	3	3[1]	3[1]	3[1]			
		DD																			
	Distance of links from tip of nose (ft)									20	20	30	30	40	40	40[2]	10[2]	20[2]			
	Required distance behind rocking rollers (ft)									74	81	86	93	100	106	106	113	117			
TD	Bays in nose	SS									6	7	6	5	5	5[1]	6[1]	7[1]	7[1]		
		DS											2	3	4	4[1]	4[1]	4[1]	4[1]		
		DD																			
	Distance of links from tip of nose (ft)										20	20	30	30	40	40	10[2]	10[2]	20[2]		
	Required distance behind rocking rollers (ft)										77	84	90	96	103	106	112	125	126		
DT	Bays in nose	SS											5	5	5	5	5[1]	5[1]	6[1]	7[1]	7[1]
		DS											3	3	4	5	5[1]	5[1]	6[1]	5[1]	5[1]
		DD																			
	Distance of links from tip of nose (ft)												30	30	30	40	40	40	10[2]	20[2]	30[2]
	Required distance behind rocking rollers (ft)												91	96	102	109	112	116	131	132	135
TT	Bays in nose	SS														5[1]	5[1]	6[1]	6[1]	6[1]	7[1]
		DS														5[1]	6[1]	5[1]	6[1]	6[1]	5[1]
		DD																2[1]	2[1]	4[1]	6[1]
	Distance of links from tip of nose (ft)															40	40	40	10[2]	20[2]	30[2]
	Required distance behind rocking rollers (ft)															94[3]	96[3]	102[3]	112[3]	115[3]	117[3]

[1]Spans launched incomplete, see adjacent table
[2]Additional links required 40 feet from tip of nose
[3]Estimated

Notes: (LAUNCHING BRIDGES)
1. Launch until near-bank rocking rollers are under last TT bay of initial construction.
2. Add up to six bays TT to tail of initial construction; This completes all but the 210-foot span
3. Continue launching until near-bank rocking rollers are under last TT bay added in step 2
4. Add remainder of TT bays to complete bridge (210-foot span only)
5. Add five bays DS nose-type construction to tail of bridge
6. Launch forward until first three DT bridge bays are beyond far-bank rollers
7. Complete first three bridge bays by converting to TT and adding transoms
8. Pull bridge back to final position, remove DS tail, add decking where needed, and jack down

SPANS LAUNCHED INCOMPLETE

TYPE OF CONSTRUCTION	SPAN (ft)	BAYS MINUS DECKING & STRINGERS	PARTIAL BAY IN INITIAL CONSTRUCTION	BRIDGE BAYS IN INITIAL CONSTRUCTION*
SS	100	4		
DS	140	6		
TS	150	6		
	160	10		
DD	160	7		
	170	7		
	180	12	2	
TD	160	3		
	170	10		
	180	All		
	190	All	3 1/3	
DT	170	3		
	180	8		
	190	All		
	200	All	3	
	210	All	5	
TT	160	3		14
	170	6		14
	180	6		14
	190	All		15
	200	All		14
	210	All		13

First 3 bridge bays are constructed DT with only 1 transom per bay. Last bridge bay is constructed DT because of staggered construction necessary when adding subsequent bays

WEIGHT PER BAY

TYPE OF CONSTRUCTION	WEIGHT PER BAY (tons)
SS bridge	2.76
DS bridge	3.41
TS bridge	4.01
DD bridge	4.66
TD bridge	5.88
DT bridge	5.46
TT bridge	8.29
SS launching nose	1.00
DS launching nose	1.64
DD launching nose	2.90
Decking:	
Stringers only	0.79
Chess and steel ribbands	0.66
Footwalks	0.17
Overhead bracing (supports, transoms, sway bracing, and chord bolts)	0.54
Wear tread and truss guards	0.35

Note:
Footwalks, wear treads, and truss guards not included; Overhead bracing included on DT and TT

NUMBER OF JACKS NEEDED AT EACH END OF BRIDGE

TYPE OF CONSTRUCTION	SPAN (ft)	JACKS NEEDED AT EACH END OF BRIDGE
SS	30-100	2
DS	50-140	4
TS	80-140	4
	150-160	6
DD	100-120	4
	130-180	6
TD	110-140	6
	150-190	8
DT	130	6
	140-180	8
	190-210	10
TT	160-170	10
	180-210	12

NUMBER OF ROCKING ROLLERS NEEDED

TYPE OF CONSTRUCTION	SPAN (ft)	NEAR BANK	FAR BANK
SS	30-100	2	2
DS	50-80	2	2
	90-100	2	2
	110-140	4	2
TS	80-160	4	2
DD	100-130	4	2
	140-180	4	4
TD	110-120	4	2
	130-190	4	4
DT	130-210	4	4
TT	160-210	4	4

Table A-2 ***Components of a panel bridge, Bailey type M2***

NOMENCLATURE	AVERAGE UNIT WEIGHT (lb)	QUANTITY	TOTAL WEIGHT (lb)
Bearer, footwalk	23	80	1,840
Bolt, bracing, bridge	1	1,200	1,200
Bolt, connector, chord	7.5	400	3,000
Bolt, end-post, spares	0.75	24	18
Bolt, ribband, guardrail J	4.5	400	1,800
Brace, sway	68	64	4,352
Chess, M2	65	336	21,840
Clamp, transom	7	600	4,200
Footwalk, aluminum assy		40	
Footwalk, wood	104	32	3,328
Frame, bracing, bridge	44	64	2,816
Nut, plain, hexagon		24	
Panel, truss, bridge	577	130	75,010
Pedestal, ramp	93	16	1,488
Picket, steel	12	40	480
Pin, connector, panel, 8 5/16"	6.1	400	2,400
Pin, connector, panel, 7 9/16"	5.8	38	220
Pin, sway-brace	1.1	50	55
Plate, base, bearing	381	8	3,048
Plate, tie	3.5	42	147
Post, end, female	130	16	2,080
Post, end, male	121	16	1,936
Post, footwalk	10	80	800
Raker, side, strut	22	64	1,048
Ramp, button	348	16	5,568
Ramp, plain	338	32	10,816
Retainer, bridge pin	0.13	1,000	130
Ribband, guardrail	162	48	7,776
Rope, manila, 2" x 600'	7.5 ft/lb	1	80
Screw, cap, hexagon, 4½"		24	
Shoe, bearing, 4 5/16"	68	16	1,088
Stringer, button	267	36	9,612
Stringer, plain	260	72	18,720
Tape, luminous, 1" x 50 yd		2	
Transom, trestle	618	56	34,608
Total			233,400

Table A-3 ***Erection equipment for a panel bridge, Bailey type M2***

NOMENCLATURE	AVERAGE UNIT WEIGHT (lb)	QUANTITY	TOTAL WEIGHT (lb)
Bag, Bailey bridge parts and tools	2	50	100
Bar, carrying	8	40	320
Block, double, for ¾" rope	8	8	64
Block, triple, for 1" rope	20	4	80
Block, snatch, for ¾" rope	6.3	4	25
Extractor, pin	18	4	72
Hammer, rubber-faced	4	45	180
Holdfast, complete w/9 pickets	160	12	1,920
Jack, ratchet-lever, 15-ton	128	10	1,280
Jack, chord	82	12	984
Lever, panel	48	12	672
Link, launching-nose, Mk II	28	24	692
Lumber, softwood, dimension 3" x 6" x 4'6"	18	48	864
Lumber, softwood, dimension 6" x 6" x 4'6"	52	144	7,488
Nail, wire, steel		300	300
Roller, plain	116	12	1,392
Roller, rocking	206	12	2,472
Roller, transom, Bailey bridge	12	4	48
Rope, sisal, lashing, ⅜" x 25'	3.3	88	290
Rope, sisal, ¾" x 600"	102	2	204
Rope, sisal, 1" x 600"	156	2	312
Shackle, anchor-type	5	4	20
Shoe, jack, 4 3/16" high	36	8	288
Sledge, blacksmith, 8-lb	8	12	96
Spike, ⅜" x 8"		20	20
Template, rocking-roller	78	8	624
Template, plain-roller	22	12	264
Tongs, carrying, bridge-erection	13	20	260
Wedge, wood	12	16	192
Wire-rope assembly, single-leg	12	4	48
Wrench, ratchet, reversible, with 1⅛" and 1⅞" sockets, for ¾" and 1¼" bolts	13	30	390
Wrench, socket, offset 90 degrees, 1⅛", for ¾" bolts	12	40	480
Wrench, structural, 1⅛", for ¾" bolts	2	60	120
Wrench, structural, 1½", for 1" bolts	4.7	30	141
Wrench, structural, 1⅞", for 1¼" bolts	5.6	40	224
Total			22,926

Table A-4 ***Bridge conversion set No. 3, Bailey type, panel crib pier, fixed M2****

NOMENCLATURE	AVERAGE UNIT WEIGHT (lb)	QUANTITY	TOTAL WEIGHT (lb)
Bag, transport	2	30	60
Bearing, crib	37	24	888
Bearing, junction-link	217	6	1,302
Bolt, bracing	1	36	36
Bolt, chord	7.5	8	60
Brace, sway, M2	68	12	816
Capsill, crib	251	12	3,012
Chess, junction, M2	149	4	596
Clamp, chord	11	32	352
Clamp, transom	7	32	224
Clip, retainer, steel	0.13	200	26
Frame, bracing	44	4	176
Link, junction	36	6	216
Link, launching-nose, Mk II	28	6	168
Pin, panel	6.1	120	732
Pin, sway-brace (spare)	1.1	2	2
Plate, tie	3.5	16	56
Post, junction, span, female	202	6	1,212
Post, junction, span, male	194	6	1,164
Raker	22	16	352
Total			11,450

Note:
One bridge conversion set No. 3 makes two crib-pier loads

Table A-5 ***Number of standard truck loads for different spans and assemblies***

		TYPE OF CONSTRUCTION																																		
		SS								DS										TS													DD				
SPAN (ft)		30	40	50	60	70	80	90	100	50	60	70	80	90	100	110	120	130	140	80	90	100	110	120	130	140	150	160	100	110	120	130	140	150	160	170	180
Parts and grillage load*, #1		1	1	1	1	1	1	1	1	(*)	(*)	1	1	1	1	1	1	1	1	(*)	(*)	1	1	1	1	2	1	1	(*)	(*)	(*)	2	2	(*)	2	(*)	2
Launching-nose load, #2		1	1	1	1	1	1	2	2	1	1	1	1	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
Panel load, #3		1	1	2	2	2	2	2	3	3	3	4	4	4	5	5	6	6	7	6	6	7	8	9	9	10	10	11	9	10	11	12	13	14	15	18	19
Transom load #4		2	2	2	3	3	4	4	3	4	3	4	4	4	3	5	5	5	6	6	4	4	5	5	5	6	6	6	7	8	5	5	6	6	6	7	7
Deck load, #5		1	1	2	2	2	2	3	3	2	2	2	2	3	3	3	3	4	4	2	3	3	3	3	4	4	4	4	3	3	3	4	4	4	4	5	5
Ramp load, #6		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5
Footwalk load, #7		1	1	1	1	1	1	2	2	1	1	1	1	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
Spares load, #8		1	1	1	1	1	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	3	3	3
Overhead-bracing load, #9																																					
Total	5-ton dump	9	9	12	11	11	12	14	15	14	13	13	14	16	17	17	18	19	20	18	19	19	20	21	22	24	23	25	23	24	25	26	28	30	31	36	36
Vehicles	4-ton bolster trailer	3	3	3	4	4	5	6	5	5	4	5	5	6	5	7	7	7	8	7	6	6	7	7	7	8	8	8	9	10	7	7	8	8	8	10	10

Table A-5 ***Number of standard truck loads for different spans and assemblies****—continued*

		TYPE OF CONSTRUCTION																							
		TD									DT									TT					
SPAN (FT)		110	120	130	140	150	160	170	180	190	130	140	150	160	170	180	190	200	210	160	170	180	190	200	210
Parts and grillage load* #1		(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
Launching-nose load #2		2	2	3	3	3	3	4	4	4	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
Panel load #3		15	16	18	18	20	22	26	28	28	18	18	20	22	26	28	28	31	32	32	38	40	42	44	46
Transom load #4		8	8	5	6	6	6	7	7	8	9	9	6	6	7	7	8	8	8	11	12	7	8	8	8
Deck load #5		3	3	4	4	4	4	5	5	5	4	4	4	4	5	5	5	5	6	4	5	5	5	5	6
Ramp load #6		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Footwalk load #7		2	2	2	2	2	2	3	3	3	2	2	2	2	3	3	3	3	3	2	3	3	3	3	3
Spares load #8		2	2	2	2	2	3	3	3	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
Overhead-bracing load #9											2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	5-ton dump	29	30	34	34	36	39	45	47	47	33	33	38	39	44	46	49	52	54	49	56	58	60	62	68
Vehicles	4-ton bolster trailer	10	10	7	8	8	8	10	10	11	11	11	8	8	10	10	11	11	11	13	15	10	11	11	11

*Grillage requirements based on soil with a safe bearing pressure of 2 tons per square foot.

** These bridges require grillages which do not use materials supplied in the parts and grillage loads.

Table A-6 ***Panel crib piers that can be assembled using standard truck loads***

PIER HEIGHT	PIER TYPE OF CONSTRUCTION	STANDARD TRUCK LOADS PARTS LOAD #1	PANEL LOAD #3	TRANSOM LOAD #4	CRIB-PIER LOAD #10
6'3½"	SS (1H)	1	1	1	1
	DS (1H)	1	1	1	2
	TS (1H)	1	1	1	2
7'2½"	SS (1H)	1	1	1	1
	DS (1H)	1	1	1	2
	TS (1H)	1	1	1	2
10'10½"	SS (2V)	1	1	1	1
	DS (2V)	1	1	1	1
	TS (2V)	1	2	1	1
11'2½"	SS (1V)	1	1	1	1
	DS (1V)	1	1	1	1
	TS (1V)	1	1	1	1
11'7¼"	SS (1V)	1	1	1	1
	DS (1V)	1	1	1	2
	TS (1V)	1	1	1	2
6'6½"	SS (1H)	1	1	1	2
	DS (1H)	1	1	1	2
	TS (1H)	1	1	1	2
11'3"	SS (1V)	1	1	1	2
	DS (1V)	1	1	1	2
	TS (1V)	1	2	1	2
11'7"	SS (2V)	1	1	1	2
	DS (2V)	1	1	1	2
	TS (2V)	1	2	1	2
16'6½"	SD (1H-1V)	1	1	1	2
	DD (1H-1V)	1	1	2	2
	TD (1H-1V)	1	2	1	2
17'0"	SD (2V-1H)	1	1	1	2
	DD (2V-1H)	1	2	1	2
	TD (2V-1H)	1	3	1	2
21'3"	TD (1V-1V)	1	2	1	2
21'7"	DD (2V-1V)	1	2	1	2
	DD (2V-1V)	1	2	1	2
	TD (2V-1V)	1	3	1	2
	DD (2V-2V)	1	2	1	2
31'7"	DT (2V-2V-2V)	1	3	2	2
	TT (2V-2V-2V)	1	5	2	2
41'7"	DQ (4V-4V-2V-2V)	1	6	3	4
	TQ (4V-4V-2V-2V)	1	9	3	6
51'7"	D5 (4V-4V-2V-2V-2V)	1	7	4	5
	T5 (4V-4V-2V-2V-2V)	1	10	4	6

POSITION OF ROCKER BEARING
BASE OF PIER
TOP OF PIER

Table A-7 ***Classes of Bailey bridge M2 (by type of construction and type of crossing)***

TYPE OF CONSTRUCTION	RATING	SPAN (ft) 30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
SS	N	30	24		20	20	16	12	8											
		30		24																
	C	42	36	33	30	24	20	16	12											
		37	34	31	29															
	R	47	40	36	33	30	24	19	14											
		42	38	35	32	30														
DS	N			75	75	60	50	40	30	20	16	12	8							
				70	65	60	55	45	30											
	C			83	77	68	60	50	37	30	23	18	14							
				76	73	69	60	50	39	32										
	R			88	85	78	66	55	42	34	27	21	17							
				84	79	75	64	55	44	36	30									
TS	N						85	65	50	35	30	20	16	12	8	4				
							80	65	55	40	35									
	C						95	74	57	47	38	31	24	18	15	10				
							90	75	60	49	41	33								
	R						100*	82	64	52	43	35	29	22	17	13				
							90*	82	66	54	45	38	31							
DD	N								80	65	45	35	30	24	16	12	8			
									80	70	55	45	35							
	C								86	72	57	47	39	32	25	19	15			
									90	76	61	50	42	35						
	R								96	80	64	53	44	36	30	24	18			
									90	83	68	56	48	40	33					
TD	N									90	75	55	45	35	30	20	16	12		
										90*	80	60	55	45	35					
	C									100*	83	65	57	47	37	31	24	18		
										90*	90*	72	62	51	41	34				
	R									100*	91	74	64	54	45	37	29	22		
										90*	90*	80	70	58	48	40	32			
DT	N											70	70	60	55	45	35	30	20	16
												80	70	60	55	50	45	35		
	C											80	80	77	69	57	48	39	32	25
												90*	90*	85	78	64	58	43	36	
	R											90	88	85	80	64	55	46	38	31
												90*	90*	90*	89	74	60	51	43	35
TT	N														80	70	55	45	35	24
															75	70	60	55	40	
	C														100	80	66	59	48	38
															90*	90*	75	66	52	43
	R														100*	90	77	68	55	46
															90*	90*	87	77	62	51

Note:
N=Normal
C=Caution
R=Risk
1 Upper figure represents wheeled-load class
2 Lower figure represents tracked-load class

Table A-8 ***Formulas for computing number of parts and spares for two-lane bridges and noses***

PART	BRIDGE CONSTRUCTION	BRIDGE FORMULA[1]	BRIDGE SPARES[2]	NOSE FORMULA[3]	NOSE SPARES[2]
Bearing, footwalk	All types	4N+2	2 or 4		
Bearing	SS-DS	8			
	DS-DD	12			
	TS-TD	12			
	TS-QD	14			
	DD-QD	14			
	DT-QT	14			
Bolt, bracing	SS-DS	12N+8	25%	6n+2	25%
	DS-DD	24N+12			
	TS-TD	30N+14		8n	
	TS-QD	36N+20			
	DD-QD	40N+24		8n	
				8n+36(140′)	
				8n+52(150′-160′)	
	DT-QT	56N+40			
Bolt, chord	DS-DD	4N	10%		
	TS-TD	6N			
	TS-QD	8N			
	DD-QD	16N			
	DT-QT	40N			
Bolt, end-post (spares)	All types		4		
Bolt, ribband, guardrail or curb	All types		10%		
Bridge		16N			
Ramp		64			
Brace, sway					
wo overhead bracing	All types	4N	10% to 4 max	SS-DS and DS-DD 2n; rest 4n	1 or 2
w overhead bracing	DT-QT	8N-4			
Chess	All types		10% to		
Bridge		26N	20 max		
Ramp		104			
Clamp, transom	SS-DS	10N	10% to 20 max	4n+2	10%
	DS-DD	14N			
	TS-TD	21N		6n+3	
	TS-QD	22N		4n+2	
	DD-QD	18N		4n+2	
				4n+19 (140′)	
				4n+25 (150′-160′)	
	DT-QT	18N			
Clip, retainer	TS-TD	24N+18	25% to 70 max	8n-8	25%
	TS-QD	28N+20			
	DD-QD	32N+16		8n-8	
				8n (140′)	
				8n+8 (150′-160′)	
	DT-QT	48N			
Footwalk	All types	2N	2		
Frame, bracing	SS-DS	N	10%		1 or 2
	DS-DD	4N+1			
	TS-TD	4N+1			
	TS-QD	6N+2			
	DD-QD	8N+4			
				9 (140′)	
				13 (150′-160′)	
	DT-QT	12N+8			

Table A-8 ***Formulas for computing number of parts and spares for two-lane bridges and noses***—*continued*

PART	BRIDGE CONSTRUCTION	BRIDGE FORMULA[1]	BRIDGE SPARES[2]	NOSE FORMULA[3]	NOSE SPARES[2]
Panel	SS-DS	4N	10% to 10 max	3n	10%
	DS-DD	8N			
	TS-TD	12N		4n	
	TS-QD	14N			
	DD-QD	16N		4n	
				4n+8 (140′)	
				4n+12 (150′-160′)	
	DT-QT	24N			
Pedestal, ramp	All types	16			
Pin, panel	SS-DS	8N+8	20% to 50 max	6n-6	20%
	DS-DD	16N+12			
Pin, sway-brace (spares)	All types		12		20% to 30%
Plate, base	SS-DS	6			
	DS-DD	6			
	TS-TD	6			
	TS-QD	8			
	DD-QD	8			
	DT-QT	8			
Plate, tie	TS-TD	4N+2	10%		
	TS-QD	2N+2			
Post, end, female	SS-DS	4	2		
Post, end, male	DS-DD	6	2		
	TS-TD	9			
	TS-QD	10			
	DD-QD	8			
	DT-QT	8	10% to 4 max		
Post, footwalk	All types	4N+2	10%		
Raker	SS-DS	4N+4			
	DS-DD	4N+4		3n+1	2
	TS-TD	3N+3			
	TS-QD	4N+4			
	DD-QD	4N+4		4n	
	DT-QT	4N+4			
Ramp, button	All types	16			
Ramp, plain	All types	32			
Ribband, guardrail or curb	All types				
Bridge		4N			
Ramp		16			
Stringer, button	All types	4N	10%		
Stringer, plain	All types	8N	10% to 4 max		
Support, bracing, overhead	DT-QT	4N	10% to 4 max		
Transom				SS-DS	
Bridge				DS-DD	
wo overhead bracing	All types	4N+2	10% to 4 max	TS-TD 2n+1	1
				TS-QD	
w overhead bracing	DT-QT	6N+2		DD-QD 2n+1	
Ramp	All types	4		2n+2(140′-160′)	

[1]N = number of bays in bridge
[2]Spares are not included in formulas and must be added
[3]n = number of bays in nose (see Table 10-3)

Table A-9 Number of parts per bay for class 30 bridges

	ITEM	PLATE, BASE	BEARER, FOOTWALK	BEARING	BOLT, BRACING M-3 (WITH NUT)	BOLT, CHORD (WITH NUT)	BOLT, RIBBAND GUARDRAIL, T, M-3	BRACE, SWAY, M-3 (COMPLETE WITH PINS)	BRACE, SWAY, OVERHEAD EXTENSION, M-3 (WITH PIN)	CHESS, M-3	CLAMP, TRANSOM, M-3	FOOTWALK	FRAME, BRACING, M-3	PANEL	PEDESTAL, RAMP, M-3	PIN, PANEL (COMPLETE WITH RETAINER CLIP)	PIN, PANEL, HEADLESS, M-3 (OD)	POST, END, FEMALE	POST, END FEMALE, M-3	POST, END, MALE	POST, END, MALE, M-3	POST, FOOTWALK	RAKER, M-3	RAMP, PLAIN	RAMP, BUTTON	RIBBAND, GUARD-RAIL (STEEL)	RIBBAND, GUARDRAIL, LONG (STEEL), M-3	STRINGER, BUTTON	STRINGER, BUTTON, LONG, M-3	STRINGER, PLAIN	STRINGER, PLAIN, LONG, M-3	SUPPORT, BRACING, OVERHEAD	PLATE, TIE	TRANSOM, M-3	NUMBER OF UNITS	TOTAL WEIGHT (lb)	TOTAL WEIGHT (short tons)
	UNIT WEIGHT (lb)	381	22	68	1.0	7.5	.75	72.5	20	130	7	104	42	577	97	6.0	5.8	130	119	121	110	10	25	338	349	162	175	267	293	260	282	150	3.5	648			
END BAY AT TAIL OF BRIDGE	SS	2	4	2	4		8	2		13	4	2		2		8		2				4	2			2		2		5				2	70	8,073	4.04
	DS	2	4	4	12		8	2		13	8	2	2	4		16		4				4	2			2		2		5				2	98	9,791	4.90
	TS	2	4	4	16		8	2		13	12	2	2	6		20	4	6				4				2		2		5			2	2	118	11,241	5.62
	DD	2	4	4	20	8	8	2		13	8	2	4	8		28		4				4	2			2		2		5				2	132	12,323	6.16
	TD	2	4	4	28	12	8	2		13	12	2	4	12		36	6	6				4				2		2		5			2	2	168	14,997	7.50
	DT	2	4	4	20	8	8	2		13	8	2	4	8		28		4				4	2			2		2		5				2	132	12,323	6.16
	TT	2	4	4	28	12	8	2		13	12	2	4	12		36	6	6				4				2		2		5			2	2	168	14,997	7.50
INTERMEDIATE BAY	SS		4		4		8	2		13	4	2		2		4						4	2			2		2		5				2	60	6,891	3.45
	DS		4		12		8	2		13	8	2	2	4		8						4	2			2		2		5				2	80	8,189	4.09
	TS		4		24		8	2		13	12	2	4	6		12						4				2		2		5				2	102	9,441	4.72
	DD		4		20	8	8	2		13	8	2	4	8		16						4	2			2		2		5				2	110	10,097	5.35
	TD		4		36	12	8	2		13	12	2	6	12		24						4				2		2		5				2	146	13,161	6.58
	DT		4		28	20	8	4	2	13	8	2	6	12		24						4	2			2		2		5		2		3	151	14,368	7.18
	TT		4		48	28	8	4	2	13	12	2	8	18		36						4				2		2		5		2		3	201	18,044	9.02
END BAY AT HEAD OF BRIDGE	SS	2	6	2	8		8	2		13	6	2		2		4				2		6	4			2		2		5				4	80	9,459	4.73
	DS	2	6	4	16		8	2		13	12	2	2	4		8				4		6	4			2		2		5				4	106	11,149	5.57
	TS	2	6	4	32		8	2		13	18	2	4	6		8	8			4	2	6	2			2		2		5			2	4	142	12,668	6.33
	DD	2	6	4	32	8	8	2		13	12	2	6	8		12				4		6	4			2		2		5				4	142	13,725	6.86
	TD	2	6	4	56	12	8	2		13	18	2	8	12		12	10			4	2	6	2			2		2		5			2	4	194	16,448	8.22
	DT	2	6	4	40	8	8	2		13	12	2	8	8		12				4		6	4			2		2		5				4	152	13,817	6.91
	TT	2	6	4	68	12	8	2		13	18	2	10	12		12	10			4	2	6	2			2		2		5			2	4	208	16,544	8.27

Table A-10 Number of parts per bay for class 80 bridges

ITEM		PLATE, BASE	BEARER, FOOTWALK	BEARING	BOLT, BRACING M-3 (WITH NUT)	BOLT, CHORD (WITH NUT)	BOLT, RIBBAND GUARDRAIL, M-3	BRACE, SWAY, M-3 (COMPLETE WITH PINS)	BRACE, SWAY, OVERHEAD EXTENSION, M-3 (WITH PIN)	CHESS, M-3	CLAMP, TRANSOM, M-3	FOOTWALK	FRAME, BRACING, M-3	PANEL	PEDESTAL, RAMP, M-3	PIN, PANEL (COMPLETE WITH RETAINER CLIP)	PIN, PANEL, HEADLESS, M-3 (DD)	POST, END, FEMALE	POST, END, FEMALE, M-3	POST, END, MALE	POST, END, MALE, M-3	POST, FOOTWALK	RAKER, M-3	RAMP, PLAIN	RAMP, BUTTON	RIBBAND, GUARDRAIL (STEEL)	RIBBAND, GUARDRAIL, LONG (STEEL), M-3	STRINGER, BUTTON	STRINGER, BUTTON, LONG, M-3	STRINGER, PLAIN	STRINGER, PLAIN, LONG, M-3	SUPPORT, BRACING, OVERHEAD	PLATE, TIE	TRANSOM, M-3	NUMBER OF UNITS	TOTAL WEIGHT (lb)	TOTAL WEIGHT (short tons)
UNIT WEIGHT (lb)		381	22	68	1.0	7.5	.75	72.5	20	130	7	104	42	577	97	6.0	5.8	130	119	121	110	10	25	338	349	162	175	267	293	260	282	150	3.5	648			
END BAY AT TAIL OF BRIDGE	SS																													3							
	DS	2	4	4	12		8	2		14	12	2	2	4		16		4				4	2				2		2	3	2			5	106	12.015	6.01
	TS	2	4	4	20		8	2		14	18	2	2	6		20	4	4	2			4	2				2		2	3	2		2	5	134	13.511	6.76
	DD	2	4	4	20	8	8	2		14	12	2	4	8		28		4				4	2				2		2	3	2			5	140	14.547	7.27
	TD	2	4	4	32	12	8	2		14	18	2	4	12		36	6	4	2			4	2				2		2	3	2		2	5	184	17.267	8.63
	DT	2	4	4	20	8	8	2		14	12	2	4	8		28		4				4	2				2		2	3	2			5	140	14.547	7.27
	TT	2	4	4	32	12	8	2		14	18	2	4	12		36	6	4	2			4	2				2		2	3	2		2	5	184	17.267	8.63
INTERMEDIATE BAY	SS																																				
	DS		4		12		8	2		13	12	2	2	4		8						4	2			2		2		5				4	86	9.513	4.76
	TS		4		24		8	2		13	18	2	4	6		12						4				2		2		5				4	110	10.779	5.39
	DD		4		20	8	8	2		13	12	2	4	8		16						4	2			2		2		5				4	116	12.021	6.01
	TD		4		36	12	8	2		13	18	2	6	12		24						4				2		2		5				4	154	14.499	7.25
	DT		4		28	20	8	4	2	13	12	2	6	12		24						4	2			2		2		5		2		5	157	15.692	7.85
	TT		4		48	28	8	4	2	13	18	2	8	18		36						4				2		2		5		2		5	209	19.382	9.69
END BAY AT HEAD OF BRIDGE	SS																																				
	DS	2	6	4	16		8	2		13	12	2	2	4		8				4		6	4			2		2		2	3			5	107	11.863	5.93
	TS	2	6	4	32		8	2		13	18	2	4	6		8	8			4	2	6	2			2		2		2	3		2	5	143	13.362	6.69
	DD	2	6	4	32	8	8	2		13	12	2	6	8		12				4		6	4			2		2		2	3			5	143	14.489	7.22
	TD	2	6	4	56	12	8	2		13	18	2	8	12		12	10			4	2	6	2			2		2		2	3		2	5	195	17.162	8.58
	DT	2	6	4	40	8	8	2		13	12	2	8	8		12				4		6	4			2		2		2	3			5	153	14.531	7.27
	TT	2	6	4	68	12	8	2		13	18	2	10	12		12	10			4	2	6	2			2		2		2	3		2	5	209	17.258	8.63

Table A-11 Material requirements of the standard-design deck-type panel bridges

ITEM	UNIT WEIGHT (lb)	USE	SINGLE-STORY DECK-TYPE BRIDGE												DOUBLE-STORY DECK-TYPE BRIDGE							
			M2 PANEL-BRIDGE DECK				LAMINATED TIMBER DECK				LAYERED TIMBER DECK				M2 PANEL-BRIDGE DECK				LAMINATED TIMBER DECK				LAYERED TIMBER DECK			
			INTERIOR BAYS		TWO END BAYS		INTERIOR BAYS		TWO END BAYS		INTERIOR BAYS		TWO END BAYS		INTERIOR BAYS		TWO END BAYS		INTERIOR BAYS		TWO END BAYS		INTERIOR BAYS		TWO END BAYS	
			NUMBER REQUIRED	TOTAL WEIGHT (lb)	NUMBER REQUIRED	TOTAL WEIGHT (lb)	NUMBER REQUIRED	TOTAL WEIGHT (lb)	NUMBER REQUIRED	TOTAL WEIGHT (lb)	NUMBER REQUIRED	TOTAL WEIGHT (lb)	NUMBER REQUIRED	TOTAL WEIGHT (lb)	NUMBER REQUIRED	TOTAL WEIGHT (lb)	NUMBER REQUIRED	TOTAL WEIGHT (lb)	NUMBER REQUIRED	TOTAL WEIGHT (lb)	NUMBER REQUIRED	TOTAL WEIGHT (lb)	NUMBER REQUIRED	TOTAL WEIGHT (lb)
Angle, 3"x3"x¾"x24'0"	173	Bracing for timber floor					2	346	5	865	2	346	5	865					2	346	5	865	2	346	5	865
Angle, 3"x3"x¾"x29'6"	212	Cross bracing					1	212	2	424	1	212	2	424					1	212	2	424	1	212	2	424
Angle, 3"x3"x¾"x32'6"	234	Cross bracing, M2 bridge	1	234	2	468									1	234	2	468								
Bearing	68	End bearings			30	2,040			30	2,040			30	2,040			30	2,040			30	2,040			30	2,040
Bolt, ¾"x15"	2.18	Ribband, laminated and layered deck					8	18	20	44	8	18	20	44					8	18	20	44	8	18	20	44
Bolt, bracing	1	Bracing frames	40	40	40	40	40	40	40	40	40	40	40	40	80	80	40	40	80	80	40	40	80	80	40	40
Bolt, ribband	1.5	Ribband, panel bridge deck	16	24	32	48									16	24	32	48								
Chess, M2	65	Floor, M2 bridge	26	1,690	52	3,380									26	1,690	52	3,380								
Frame, bracing	43.6	On end verticals of panels	10	436	10	436	10	436	10	436	10	436	10	436	20	872	10	436	20	872	10	436	20	872	10	436
Nail, 40d	1/17	Wear surface	240	14	480	28	240	14	480	28	240	14	480	28	240	14	480	28	240	14	480	28	240	14	480	28
Nail, 60d	1/10	Timber floor					200	19	400	38	266	25	532	51					200	19	400	38	266	25	532	51
Panel	577	Trusses	15	8,655	30	17,310	15	8,655	30	17,310	15	8,655	30	17,310	30	17,310	30	17,310	30	17,310	30	17,310	30	17,310	30	17,310
Pin, panel w/retainer clip	6.21	Panels and end posts	30	186	90	559	30	186	90	559	30	186	90	559	60	372	60	372	60	372	60	372	60	372	60	372
Post, end, female	129.5	End of trusses			15	1,942			15	1,942			15	1,942			15	1,942			15	1,942			15	1,942
Post, end, male	121	End of trusses			15	1,815			15	1,815			15	1,815			15	1,815			15	1,815			15	1,815
Ribband, steel	215	Curbs	4	860	8	1,720	4	860	8	1,720	4	860	8	1,720	4	860	8	1,720	4	860	8	1,720	4	860	8	1,720
Stringer, button	267	Deck	4	1,068	8	2,136									4	1,068	8	2,136								
Stringer, plain	260	Deck	8	2,080	16	4,160									8	2,080	16	4,160								
Timber, 3"x6"x12'0"	52.5	Laminated deck					40	2,100	80	4,200									40	2,100	80	4,200				
Timber, 3"x12"x10'0"	87.5	Wear surface	16	1,400	32	2,800	16	1400	32	2,800	16	1,400	32	2,800	16	1,400	32	2,800	16	1,400	32	2,800	16	1,400	32	2,800
Timber, 3"x12"x12'0"	105	Bottom layer of layered deck									10	1,050	20	2,100									10	1,050	20	2,100
Timber, 3"x12"x17'6"	153	Top diagonal layer of layered deck									14	2,142	28	4,284									14	2,142	28	4,284
Transom, M2	618	Deck, M2 bridge	4	2,472	9	5,562									4	2,472	9	5,562								
		Total weight (lb)		19,159		44,444		14,286		34,261		15,384		36,458		28,476		44,257		23,603		34,074		24,701		36,271
		(ton)		9.6		22.2		7.1		17.1		7.7		18.2		14.2		22.1		11.8		17.0		12.4		18.1

Table A-12 ***Typical*** *highway deck-type* ***panel bridges built in ETO***

LOCATION	Tiber River, Borghetto, Italy	Autobahn highway, Bayreuth, Germany	Arno River, Pisa Italy	Po River, Ostiglia, Italy
SPAN	Continuous over four spans at 80', 90', 90' and 80'	Continuous over two 55' spans	Continuous over two 85' spans	Continuous over thirteen 100' spans
CAPACITY*				
ONE WAY	Class 80	Class 80	Unknown	Class 100
TWO WAY	Class 45	Class 45		Class 55
ROAD WIDTH (ft)	24	25	20	About 22
TRUSS CONSTRUCTION	18 trusses tied together by vertical bracing frames and tie plates into 2 five-truss and 2 four-truss girders	8 trusses tied together by vertical bracing frames into 4 two-truss girders	10 trusses tied together by vertical bracing frames into 5 two-truss girders	16 trusses tied together by vertical bracing frames into 8 two-truss girders
SPECIAL BRACING	3"x3" angle cross bracing welded under bottom chords	6" channels transverse to centerline of bridge welded to top and bottom chords at 20" spacings	10" steel I-beam floor beams welded across top chords at 2'6" spacings	Angle cross bracing welded under bottom chords
DECK	3 layers of 2" timber nailed to nailing strips bolted to trusses; bottom 2 layers laid diagonally, top layer laid transversely, and surfaced with bituminous surfacing	9" flooring nailed to nailing strips bolted to trusses	2 layers of 3" timber nailed to nailing strips bolted to floor beams	2 layers of timber nailed to nailing strips bolted to trusses; bottom layer laid transversely, top layer laid diagonally
LAUNCHING	Each girder launched separately; girder and launching nose pulled on rollers cut over gap	Each girder launched separately on rollers	Entire unit launched on rollers without a launching nose	Each girder lifted directly into place by pile-driving rig

*Capacities are those assigned to the bridge in the field; actual capacities may be greater

Table A-13 Typical railway panel bridges built in ETO

LOCATION	Kings Newton bridging school, Melbourne, Derby, England	Railway bridging school at Rakha Mines, India	Sicily	Ofanto River near Melfi, Italy
SPAN	90'	80'	120' (continuous over two 60' spans)	Three 60' spans
CAPACITY	2-8-0 armored locomotive (equivalent to Cooper's E-35)	16 B.S.S. (equivalent to Cooper's E-35)	Not known	Class 70 (modified Cooper's E-40)
NUMBER OF TRUSSES	QD	QD	TD	TD—Deck in top story
BRACING	Normal	Normal	Normal	Normal
DECKING	Ties on two lines of rail clusters (3 rails in each cluster); double transoms	6"x8"x7' ties at 1'8" centers; every third tie hook bolted to standard stringers; outer stringers omitted; double transoms	Every 7th tie spiked to standard chess on stringers; double transoms; timber treads built up on each side of rails for highway traffic	Ties at 2'6" centers; double transoms; ties bolted every 10' to plate under two transoms
BEARINGS	Standard end posts and bearings	Standard end posts and bearings		Standard end posts and bearings
CONSTRUCTION TIME				5 days
METHOD OF LAUNCHING				120' launched with 70' nose from one bank; 60' launched with tail from other bank
FIGURE REFERENCE	13-12	13-13	13-14	13-15

LOCATION	Cevaro River near Foggia, Italy	Durance River near Meyrargues, France	Durance River south of Sisteron, France	Durance River, Sisteron, France
SPAN	Three spans at 40', 80', and 40'	170' continuous over two spans of 80' and 90'	90' (continuous over two 40' spans and 10' spans and 10' wide pier)	60' span and 120' (continuous over two 60' spans)
CAPACITY	Class 70 (modified Cooper's E-40)	80-ton concentrated load string of 40-ton cars without locomotive	Modified Cooper's E-40	Modified Cooper's E-40
NUMBER OF TRUSSES	TD—deck in top story	8 trusses grouped into two 4-truss girders	6 trusses grouped into two 3-truss girders	6 trusses grouped into two 3-truss girders
BRACING	Normal	Bracing frames and tie plates	Tie plates in each girder; angle iron vertical cross bracing welded to panel verticals; horizontal braces welded to bottom chords adjacent to panel verticals	Bracing frames and tie plates—3" channel sway bracing welded under trusses
DECKING	Ties at 2'6" centers; every fourth tie bolted to plate under transoms; double transoms	Ties at 2'6" centers; chord bolted to trusses	Ties at 16" centers bolted to longitudinal timbers fixed to top chords of trusses	Ties at 2'6" centers bolted to trusses
BEARINGS	Standard end posts and bearings	Rigid distributing beam under two node points seated on timber at abutments and piers	Timber bearings	Underslung second story seated on timber at abutments; steel rocker bearings on timber pier cap
CONSTRUCTION TIME	5 days	23 days	9 days	20 days (including 60' panel crib pier)
METHOD OF LAUNCHING	120' launched with 70' nose from one bank; 40' launched from other bank	Each 170' truss placed by high line; bracing added after trusses were in place	Entire bridge cantilevered into place	60' and 120' trusses lifted directly into place by cranes
FIGURE REFERENCE	13-15		13-16	

LOCATION	Montrond bridge, Buech River, Serres, France	Pont d'Ain bridge, Ain River near Poncin, France	Suran River near Poncin, France	Arbois, France
SPAN	40' (continuous over two 20' spans)	170' (continuous over two 85' spans)	90'	70' (continuous over two 35' spans)
CAPACITY	Modified Cooper's E-40	Modified Cooper's E-40	Mofidied Cooper's E-40	Modified Cooper's E-40
NUMBER OF TRUSSES	4 trusses grouped into two 2-truss girders	9 trusses	10 trusses	6 trusses grouped into two 3-truss girders
BRACING	Tie plates in each girder; angle iron vertical cross bracing welded to panel verticals	Bracing frames, tie plates, and modified transoms	Bracing frames and tie plates; angle iron sway bracing welded under trusses	Tie plates in each girder; angle iron vertical cross bracing welded to panel verticals; horizontal braces welded to bottom chords adjacent to panel verticals
DECKING	Ties at 16" centers bolted to longitudinal timbers fixed to top chords of trusses	Ties at 2'6" centers, chord bolted to trusses	Ties at 2'6" centers, chord bolted to trusses	Ties at 16" centers bolted to longitudinal timbers fixed to top chords of trusses
BEARINGS	Timber bearings		Rigid distribution beam under two node points at each end; one end on steel plate for expansion	Timber bearings
CONSTRUCTION TIME	3 days		4 days	
METHOD OF LAUNCHING	Trusses positioned manually	Entire unit launched with 4-truss launching nose; launching links between 2nd and 3rd bays; bridge pulled across by winch, 16 jacks used to jack down	Entire bridge launched with 4-truss launching nose; bracing frames on top chord during launching only	Entire bridge launched on rollers
FIGURE REFERENCE	13-17			

LOCATION	Doubs River, Dole, France	Langley bridge, Moselle River near Charmes, France
SPAN	460' (continuous over six 76½' spans)	450' (continuous over seven 64' spans)
CAPACITY	Modified Cooper's E-40	Modified Cooper's E-40
NUMBER OF TRUSSES	10 trusses grouped into two 5-truss girders	8 trusses
BRACING	Tie plates in each girder; 4"—channel vertical cross bracing welded to panel verticals; 4"—channel horizontal braces welded to top and bottom chords in each bay	Bracing frames, tie plates, and transoms; 3"—angle sway bracing welded under trusses
DECKING	Ties at 2'6" centers, chord bolted to trusses	Ties at 2'6" centers, chord bolted to trusses
BEARINGS	Steel distributing plate under two node points set on timber pier caps; angle cleats for side guides	Modified end posts at abutments; 8'9" distributing beam under 3 node points over piers; distributing beam rocks on standard bearings on greased steel plates between angle guides
CONSTRUCTION TIME	20 days	19 days
METHOD OF LAUNCHING	one half of bridge cantilevered out from each bank; no launching nose; pulled across by winch	260' pulled by winch from one bank; 190' pulled from other bank; no launching nose used

Table A-14 ***Strength of individual panel-crib parts***

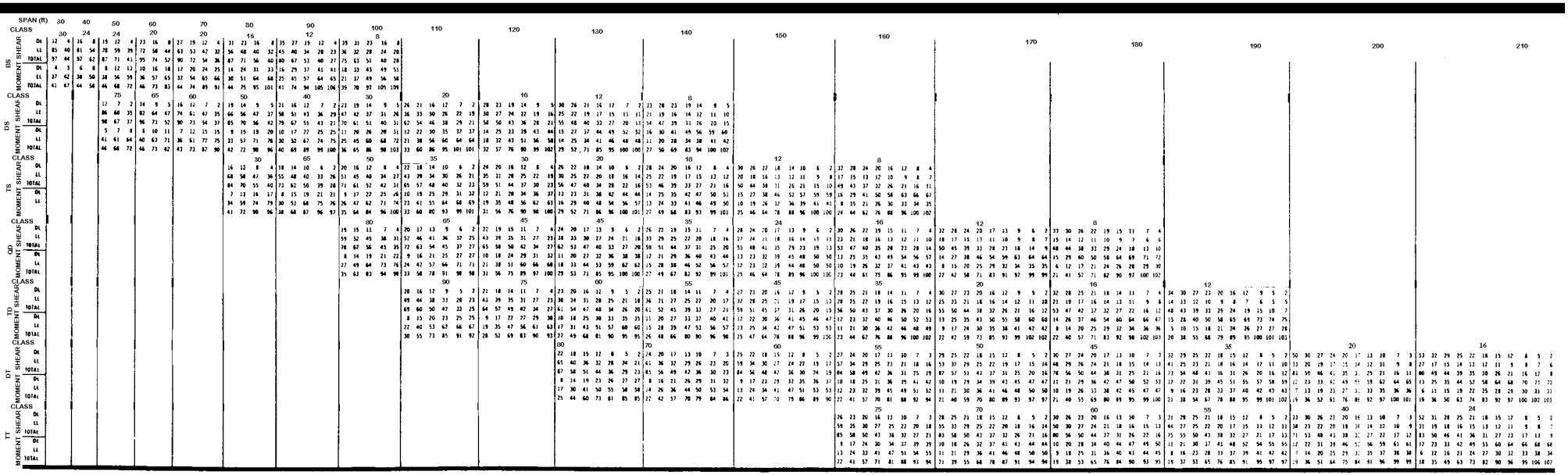
PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Span junction post	(1) Shear across joint	20	(1) 20 tons / 20 tons
	(2) Moment of resistance to bending when launching link Mk II is in position; with no shear across joint	380 ft-tons	(2) a, P, l; $\frac{Pa}{l}(l-a) =$ { 380 ft-tons (no shear) / 360 ft-tons (20-ton shear)
	With 20-ton shear across joint	360 ft-tons	
Junction link	(3) Vertical load	25	(3) 12.5 tons, 12.5 tons / 25 tons
Junction-link bearing	(4) Load at center when supported at ends only	14	(4) 14 tons
	(5) Load at center when supported for full length	25	(5) 25 tons
Crib capsill	(6) When supported at ends and center reinforced holes with load on two intermediate reinforced holes	9	(6) 4.5 tons, 4.5 tons
	(7) When supported at intermediate reinforced holes with load on two center reinforced holes	4.5	(7) 2.25 tons, 2.25 tons
	(8) When supported at end and center reinforced holes with distributed load	18	(8) 18 tons
	(9) When supported along entire length by a panel chord with load on two center reinforced holes	17	(9) 8.5 tons, 8.5 tons / panel
	(10) Tension between any two reinforced holes	34	(10) 34 tons, 34 tons
Chord clamp	(11) Tension	17	(11) 17 tons / 17 tons

Note: See Table 22-1 for strength of launching link Mk II, panel pin, panel, and bearing

Table A-15 ***Equipment and transportation required to build standard panel crib piers***

ITEM	UNIT WEIGHT (lb)	BASIS FOR COMPUTING SPARES	FIGURE REFERENCE 17-16						17-17			17-18					17-19							17-20						17-21			
			HEIGHT 6'3½"			7'2½"			6'6½"			17'0"			27'0"		10'10½"			20'10½"		30'10½"		11'7"			21'7"		31'7"		41'7"		51'7"	
			TYPE OF CONSTRUCTION																															
			SS (1H)	DS (1H)	TS (1H)	SS (1H)	DS (1H)	TS (1H)	SS (1H)	DS (1H)	TS (1H)	SD (2V-1H)	DD (2V-1H)	TD (2V-1H)	DT (2V-2V-1H)	TT (2V-2V-1H)	SS (2V)	DS (2V)	TS (2V)	DD (2V-2V)	TD (2V-2V)	DT (2V-2V-2V)	TT (2V-2V-2V)	SS (2V)	DS (2V)	TS (2V)	DD (2V-2V)	TD (2V-2V)	DT (2V-2V-2V)	TT (2V-2V-2V)	DQ (4V-4V-2V-2V)	TQ (4V-4V-2V-2V)	D5 (4V-4V-2V-2V-2V)	T5 (4V-4V-2V-2V-2V)
			NUMBER OF PARTS REQUIRED (QUANTITIES INCLUDE SPARE PARTS)																															
Bearing	68		2	4	4												2	4	4	4	4	4	4										
Bearing, crib	37	10%	2	4	7							7	13	20	13	20	2	4	7	4	7	4	7	7	13	20	13	20	13	20	22	33	22	33
Bearing, junction-link	217					2	4	6	2	4	6	2	4	6	4	6								2	4	6	4	6	4	6	4	6	4	6
Bolt, bracing	1	25%	10	10	20	10	10	20	10	10	20	20	60	80	90	120	20	40	60	70	100	100	140	20	40	60	70	100	100	140	250	320	300	380
Bolt, chord	7.5	10%										4	9	13	18	26	4	9	13	18	26	26	40	4	9	13	18	26	26	40	70	106	79	119
Brace, sway, M2	68	10% to 4 max	2	2	2	2	2	2	2	2	2	7	7	7	11	11	4	4	4	9	9	13	13	4	4	4	9	9	13	13	26	26	31	31
Capsill, crib	251		4	8	12	4	8	12	2	4	6	4	8	12		12	2	4	6	4	6	4	6	2	4	6	4	6	4	6	4	6	4	6
Chess, junction, M2	149								4	4	4	4	4	4	4	4								4	4	4	4	4	4	4	4	4	4	4
Clamp, chord	11	10%	13	26	40	18	35	43	9	18	26	13	26	40	26	40	4	9	13	9	13	9	13	4	9	13	9	13	9	13	9	13	9	13
Clamp, transom	7	10% to 20 max	4	9	13	4	9	13	4	9	13	13	26	40	33	51	9	18	26	26	40	62	92	9	18	26	26	40	62	92	106	158	123	185
Frame, bracing	44	10%											9	9	13	13		4	4	9	9	13	13		4	4	9	9	13	13	40	40	48	48
Link, junction	36					2	4	6	2	4	6	2	4	6	4	6								2	4	6	4	6	4	6	4	6	4	6
Link, launching, Mk II	28					2	4	6	2	4	6	2	4	6	4	6								2	4	6	4	6	4	6	4	6	4	6
Panel	577	10% to 10 max	2	4	7	2	4	7	2	4	7	7	13	20	22	33	4	9	13	18	26	26	40	4	9	13	18	26	26	40	53	79	62	92
Pin, panel	6	20% to 50 max	24	48	72	34	67	101	34	67	101	58	115	173	134	202	19	38	58	58	86	77	115	46	91	137	110	166	130	194	187	281	206	308
Plate, base	381		2	2	2												2	2	2	2	2	2	2										
Plate, tie	3.5	10%			4			4			4			9		13			9		13		18					13		18		31		35
Post, junction, span, female	202								2	4	6	3	4	6	4	6								2	4	6	4	6	4	6	4	6	4	6
Post, junction, span, male	194								2	4	6	2	4	6	4	6								2	4	6	4	6	4	6	4	6	4	6
Raker	22	10%	4	4	4	4	4	4	4	4	4	9	9	9	13	13	9	9	9	13	13	18	18	9	9	9	13	13	18	18	31	31	35	35
Transom, M2	618	10% to 4 max	2	2	2	2	2	2	2	2	2	7	8	8	10	10	4	4	4	7	7	15	15	4	4	4	7	7	15	15	26	26	31	31
Load	Name of load		NUMBER OF LOADS REQUIRED																															
1	Parts		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	Panel		1	1	1	1	1	1	1	1	1	2	3	3	3	4	1	1	2	2	3	3	5	1	1	2	2	3	3	5	6	9	7	10
4	Transom		1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	2	2	1	1	1	1	1	2	2	3	3	4	4
10	Crib-pier		1	1	2	1	2	2	1	1	1	1	1	2	1	2	1	1	1	2	2	2	2	2	2	2	2	2	2	2	4	6	5	6

Table A-16 Shears and bending moments in percentage of maximum capacity



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